SCIENCE

DECEMBER 22, 1950

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VOLUME 112, NUMBER 2921

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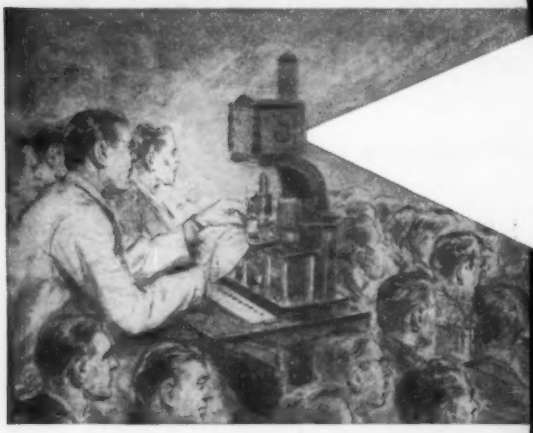

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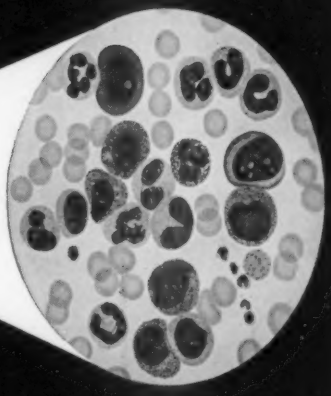

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The Federal Computing Machine Program[1]

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THE GOAL OF THIS PAPER is a modest one, namely, to lay before those who have not had the occasion or the opportunity to consider the total interest of the government in the computing machine program in this country some of the aims and problems that enter into our thinking when we try to determine policies and plans in this field. Since there is obviously not complete unanimity of opinion, it must be understood that I shall limit this discussion to my own opinions; and, since the government's interest must obviously include activities that cannot be discussed here, there will be no attempt to cover the field completely. In fact, I shall not refer even to all unclassified machines. For an adequate discourse on the military applications of automatically sequenced electronic computers, I direct you to recent Steve Canyon comic strips in which a wonderful electronic brain that could see and shoot down planes at great distances was saved from the totalitarian forces of evil.

The problem of choosing material for this discussion has been a difficult one. There are those who know well the status of virtually all the machine developments in this country, and whose chief interest is in the technical advances in machine construction that have occurred during the past few months. On the other hand, a number of us are interested primarily in getting a bird's-eye view of the situation. I shall address most of my attention to this second group.

Analog Computers

Although the substantial government interest, expressed in plans and money, is, and has been for some time, in the digital field, it would be false to give the impression that no considerable sums of money have been invested by the government in analog computers; or that such machines and other analog computers built without government support are not playing an important and useful role in the scientific and industrial laboratories of the country. To be sure, the Bush differential analyzer is probably being used less extensively now than during World War II, and this for reasons largely economic. But other machines whose primary function is to solve ordinary differential equations are proving to be extremely useful, and will, I believe, continue to carry their load of problems for a long time. I mention in particular the Reac, developed by the Reeves Instrument Company under a Special Devices Center contract for the Office of Naval Research. This is an electromechanical machine which has been used at Reeves on problems submitted primarily by aircraft companies, and dealing with the design of guidance and control systems, with stabilization, with the dynamics of the combustion process, and with related problems. The rapid rate at which solutions are obtained, and the ease with which parameters may be varied or additional factors introduced, permit a broad investigation before design is undertaken. Goodyear Aircraft, under an Air Force contract, has developed a similar machine.

In addition to pure simulation, this type of computer may be used as a testing device. For example, in the auto-pilot problem, instead of simulating the automatic pilot by means of an equation, the actual auto pilot may be incorporated in the machine in such a manner that its response to typical operating conditions can be observed in the laboratory. In this case the machine has only the equations of aircraft motion patched in, and produces a voltage proportional to the pitch rate. This is used to drive a pitch table at a rate equal to that in the true aircraft. The auto pilot mounted on this table reacts as it would under flight conditions, and its output signals, which are normally used to position the control surfaces, are fed back to the computer.

Reac machines are available commercially, and more than sixty of them are in use at industrial and government laboratories; in many cases changes and adaptations of the machine have been made to make it more suitable for the problems of the local laboratory.

[1] Based on an address delivered, by invitation, at the meeting of the Association for Computing Machinery, in Washington, D. C., September 8, 1950.

Whether these machines will continue to be used extensively after digital machines become widely available, and their use is no longer surrounded by difficulties of operation, seems hardly worth discussing at this time.

Other machines of the differential analyzer type, which are electronic and thus attain greater speed, but with somewhat less accuracy, have been built in the Research Laboratory of Electronics at MIT, and by George A. Philbrick Researches. The MIT electronic differential analyzer was built merely because, like analog machines in so many other laboratories, it was a handy gadget to solve problems arising in the laboratory. The Philbrick machine is sold commercially. These electronic differential analyzers are well suited to solve not only linear but nonlinear ordinary differential equations, and they have been used effectively on certain partial differential equations for which their very fast time of solution particularly suits them.

Other analog machines, such as the flight simulator at MIT, have been sponsored recently under direct government contract; and the biggest differential analyzer of them all, TYPHOON, has just been dedicated.

Some important analog machines such as the ANACOM at Westinghouse have been developed by commercial companies and universities. All these machines, and others too numerous to mention, are proving their usefulness, and are enthusiastically supported by their users. Some, such as Professor McCann's machine at California Institute of Technology, built without government support, sell their time, and are very busy with problems originating in industry. Others spend their full time solving problems originating in their own laboratories.

There is, of course, vastly more analog than digital equipment that has been built without government support; but in the case of many of the larger installations, at least, the government and its contractors make extensive use of the equipment.

The machines I have been discussing have their principal uses in problems arising outside what we usually think of as a strictly scientific environment. One machine which the Office of Naval Research has sponsored, and which Professor Raymond Pepinsky described at a meeting of the Association for Computing Machinery at Oak Ridge a little over a year ago, is being used extensively at Penn State College for the analysis of crystallographic structure problems. (This is by no means the only analog machine designed for this purpose, as D. R. Hartree has pointed out in his book on *Calculating Instruments and Machines* [Champaign: Univ. Ill. Press, pp. 47, 48, 1949]). The enthusiasm of scientists working in the field of structure analysis here and abroad has led to the suggestion that copies of Pepinsky's machine be made available for sale commercially. Undoubtedly the computing involved in the crystallographic structure problem is extensive. My own impression, however, after listening to two days of discussions at a meeting of crystallographers from Europe and the United States, was that the substantial appeal of the machine was rather in its clever and fast display equipment than in the computing element itself. A special-purpose computer using digital techniques, but with display equipment as effective as that in the Pepinsky computer, would probably be vastly more satisfactory than the present machine, which requires the crystallographer to take a trip around the laboratory turning little knobs before the machine is ready to go—and to repeat this trip whenever a variation of the problem is tried. Since the problem is solved by successive variations of the signs of appropriate coefficients in a multiple Fourier sum, the analysis of a structure involves a fair amount of exercise—a device for avoiding the sedentary habits of the academic profession which may be desirable.

Thus, though the Pepinsky computer is undoubtedly serving an extremely useful purpose for scientists engaged in crystallographic structure analyses, and is turning out important results long before digital machines have become available for this work, it seems clear that this is not an argument for the continuation of extensive analog techniques in this field. If I may paraphrase a remark made by S. H. Caldwell at the Oak Ridge meeting of the association, I should like to emphasize again the advantages to be derived in scientific as well as in military applications of computers from adopting the broad point of view that recognizes merit in both the analog and the digital aspects of the computer art and derives assistance from whatever phase is relevant to the problem in hand. As one who has suspected from the beginning that all oscilloscope displays were manipulated by a little man standing in hiding near by, I am happy now to concede that in several of the problems we are now attacking the introduction of visual display equipment has substantial merit.

I should like to suggest that at this stage in the computer art, a rough basis for the selection of an appropriate type of machine to perform a given computation is not only the degree of accuracy desired, but also the number of inputs to be considered and varied. In problems involving differential equations, for example, the electronic differential analyzers seem particularly suitable for a very fast survey of the results obtained as relatively few parameters are varied; the REAC and the Goodyear type of machine are intermediate in the number of parameters handled and in accuracy; whereas the digital machines, when

fully exploited (and when and if the programmers and coders exist for their proper use) will in many cases permit more inputs and yield greater accuracy.

Digital Machines in the Government

I turn now to a brief consideration of digital machines of interest to government agencies. The Ordnance Department of the Army and the Bureau of Ordnance in the Navy were the pioneers in this field and are jointly responsible for the extensive array of machines now at the Ballistics Research Laboratory at Aberdeen and for the machines at the U. S. Naval Proving Ground at Dahlgren. Moreover, the Army Ordnance Department sponsorship of the automatically sequenced high-speed electronic computer at the Institute for Advanced Study has provided support for Professor von Neumann's group there; and the work coming out of this group has inspired designers in many parts of the world in the development of digital computers, and has actually given rise to groups that are copying the machine nearing completion. IBM, too, has contributed importantly to the development of the digital computer art. This company's collaboration with Professor Howard Aiken at Harvard in the building of the Mark I represented only one phase of its contribution. Throughout World War II and continuing into the present there has been heavy reliance in virtually all computer laboratories on IBM equipment. Thus it will be understood that, when I speak of the present activities of the Bureau of Standards in coordinating much of the Federal activity in the field, I am in no way suggesting that their activities represent the sole or even the principal Federal support for the development of electronic digital computers in this country.

After World War II the concern to exploit the potentialities of digital computers for the benefit of Federal departments that were not engaged extensively in military activities was expressed first by the desire of the Census Bureau to obtain a machine suitable for its use in the 1950 census. The monitoring of this development was enthusiastically undertaken on behalf of the Census Bureau by the Bureau of Standards at a time when operating, automatically sequenced, electronic digital machines seemed to be about eighteen months in the future. (They continued to seem about eighteen months in the future for the next three years.) Actually the Census machine is still not available to the Census Bureau, but I understand that some Census problems are being run on the Seac now at the Bureau of Standards.

Other Federal bureaus, including the Office of Naval Research, were happy to use the services of the Bureau of Standards as a purchasing and monitoring agency, and thus the machine development section of what later became the Bureau's National Applied Mathematics Laboratories came into existence. When the Office of Naval Research contracted for its machine, there were optimistic predictions that the machine would be built quickly without substantial research or development, by using existing techniques. It is interesting to note that the Bureau of Standards, about two years ago, having failed to secure delivery from its various contractors, itself began, under the financial sponsorship of the USAF, to construct in its own laboratories two machines which were, again, to be built "with a minimum of development;" and that these two machines, the Seac, now on display in Washington, and the Swac, recently dedicated in Los Angeles, have actually reached the early test and operating stages before any of the machines for whose purchase the Bureau has contracted.

Outside the program monitored by the Bureau of Standards, the Office of Naval Research has had a very limited program in support of electronic digital computers. In particular, ONR is giving partial support to the so-called Caldic at the University of California in Berkeley. The guiding principle for the design of this computer has been minimization of overall cost, including construction, maintenance, programming, and power. Careful plans have been drawn for this machine, and drawings and design information will be available to small research centers that need an installation on the spot.

In line with these objectives, a magnetic drum memory having a storage capacity of 10,000 nine-decimal digit numbers, has been completed. This capacity was provided not only to accommodate large problems, but also to simplify the input-output equipment and the programming—a feature that will be appreciated by those who have written programs for machines with small memories.

Howard Aiken has recently emphasized the desirability of having a relatively simple and cheap machine available to small universities. It was precisely a concern that an adequate machine should be available quite generally and inexpensively to university people that induced ONR two years ago to encourage the California group to proceed with the design and construction of what we have referred to as an "intermediate" computer. Professor Morton, the designer of the Caldic, has now actually completed the design and taken substantial steps in the building of such a machine. We expect that cheapness, like other components, will develop with new ideas, stepwise and not by command, but Professor Morton's estimate of the cost to reproduce this machine in a university laboratory is under $50,000.

I have no doubt that many of the larger research centers will prefer to copy other machines that are

now nearing completion. And I believe that these are the machines to which Louis Ridenour, of the University of Illinois, referred in his recent article in the *Journal of Applied Physics* when he said,

> Some workers in the computing-machine field seem quite pessimistic about the ultimate wide availability of such machines, on the grounds that they are complicated, expensive, and difficult to keep in order. This is a point of view with which I entirely disagree. I fully expect that a competent high-speed computer will very soon be regarded as an important and inevitable part of the research equipment of any university having even the most modest research pretentions (21, [4], [April 1950]).

Present State of the Computer Art

I shall try now to summarize briefly recent changes in the state of the computer art. Several electronic digital computers, including the SEAC (the Bureau of Standards Eastern Automatic Computer) and the SWAC (the Bureau of Standards Western Automatic Computer), have been assembled during the past year and are under test, and others are almost entirely assembled. One can therefore expect during the coming year that many debatable questions concerned with such things as number base, word length, and checking systems will have partial answers as experience is gained in the use of these computers. It must be realized that these machines are at present experimental laboratory equipment. One of their main uses in the next few years will be as research tools from which we may hope to learn much about computing and computing equipment.

The EDVAC, the BINAC, and the SEAC are the acoustic computers completed thus far in this country, and a UNIVAC and a Raytheon computer should be completed within the next year. The EDVAC has been moved to Aberdeen, where it has been reassembled and is undergoing tests. The arithmetic element and mercury delay memory have operated satisfactorily, and the dispatcher has been made to perform all machine orders. The input-output equipment is being redesigned. The BINAC has been moved to Northrop Aircraft, where it is being reassembled.

The Eckert-Mauchly Computer Corporation, designer of the UNIVAC, has recently stepped up production schedules; one complete system is being assembled, and parts of another are ready for assembly. These will be followed by a lot of at least three additional systems. It is anticipated that production of the first lot will be completed and tested this year.

At Raytheon, the construction of the machine proceeds slightly behind schedule. The auxiliary six-channel magnetic tape storage uses a newly designed thin magnetic head, and a particularly efficient tape-handling mechanism, which Raytheon is now manufacturing for other machine construction groups.

The National Bureau of Standards SEAC, now assembled at the Bureau, is a general-purpose electronic digital computer which incorporated into its design much that had been learned by others working in the field. The construction of this computer was undertaken with the support of the Office of the Air Comptroller. Initially, the computer was provided with a 512-word internal acoustic memory unit, a prototype 32-word electrostatic memory unit (utilizing the Williams technique), and modified teletype input-output equipment. It is intended that a new type magnetic wire handling mechanism, an experimental high-speed printing device capable of writing 30 lines per second with 50 digits in a line, and magnetic tape input-output mechanisms will be added during 1950. A 45-tube, 512-word electrostatic memory is being constructed for incorporation and evaluation with the computer. The machine has been so designed that both the serial type acoustic and parallel type electrostatic memories can be used simultaneously, and provision has been made for possible increase of the combined memory capacity up to 4,000 words. During the shakedown period of the machine several small problems have been completed. One such completed test problem was the computation of 31 skew rays through a system of 9 lenses for the Electricity and Optics Division of the Bureau of Standards. Linear programming problems for the Office of the Air Comptroller occupy much of the time of the machine, though statistical problems have been run for the Census Bureau, and some problems in mathematical physics have been explored.

The principal general-purpose computers with magnetic drum memory are the Aiken MARK III, which is being reassembled after being moved from Harvard to Dahlgren, and a computer on order for Wright Field under contract with the Bureau of Standards, which was designed and is under development in the laboratory of the General Electric Company at Syracuse, New York. Among the design considerations, accuracy and reliable operation were foremost, and only proved principles are utilized. Operation and maintenance procedures are simplified. Unitized construction, employing about 16 basic circuits as plug-in assemblies, is used to aid design, speed maintenance, and provide for adding future improvements.

The principal machines using an electrostatic memory are the von Neumann–Bigelow–Goldstine machine at the Institute for Advanced Study (and its descendants in various other places), WHIRLWIND at MIT, and the SWAC.

The Institute for Advanced Study computer is virtually assembled. It will use a memory of the Williams type as redesigned for parallel operation by Julian Bigelow. The memory, the arithmetic element,

and the arithmetic control have been built and tested, and the central control is substantially complete. Considerable effort has been expended to minimize the number of tubes and amount of other equipment required and to make the units as compact and accessible as possible. A clever three-dimensional wiring system has been worked out, whereby leads cross at right angles to minimize cross-talk, and compactness and accessibility are secured.

For WHIRLWIND a specially designed electrostatic storage tube has been developed. At present a bank of 16 storage tubes, each storing 256 binary digits, has been installed, along with the necessary circuits for transferring information to and from the memory in a parallel fashion. The final memory is expected to be composed of 32 tubes, each storing 1,000 binary digits. In order to decrease the number of errors occurring during operation of the computer, a marginal checking arrangement for detecting deteriorating components has been worked out. In this scheme, voltages are varied in large circuit groups, inducing inferior parts to cause failure, and a test program detects and localizes possible failure.

The SWAC has recently been dedicated at the Institute for Numerical Analysis in Los Angeles. At the time of the dedication the device had an internal storage of 256 numbers of 45 binary digits each. Selection commands were available that in many cases permitted storing more short numbers than there were available storage spaces by storing two or more numbers per storage position. The machine has been used to construct tables of squares by adding successive odd numbers; and a program had been pursued which made the machine count by adding one to the number already stored in one of the storage positions.

It is hoped that the storage in each tube can be increased so that the memory capacity will become 1,000 words. A magnetic drum is to be installed as an auxiliary memory device. Numbers are to be transferred from the drum in blocks so that the numbers will become available as fast as they are needed.

THE SHAPE OF THINGS TO COME

We see, then, that the warning that I have been in the habit of giving for the past several years is no longer strictly appropriate—namely, that none of these automatically sequenced electronic machines is actually working. Nevertheless, real operating experience is now available in this country only for the earlier types of machine, the ENIAC, the MARK I and II, and the Bell Telephone Laboratories computers. But some experience with electronic automatically sequenced machines does come to us from England.

The importance of these remarks for the Federal program is only partly that we are now able to breathe a sigh of relief and hope that our predictions of great things may soon be realized. Their importance is even more that, charged as we are in the Federal government, and particularly in the military, to be at least two years ahead of the time, and operating under the pressure of the present international emergency, we are now dreaming of the special uses to which the components and machines that are now beginning to perform satisfactorily may be put—and worrying about important new components whose development we should sponsor. The obvious directions are toward simplification of circuits; the investigation of the possible use of semiconductor devices, such as transistors to replace vacuum tubes; and the exploration of promising avenues for the further development of a high-speed memory. Some work over and above that being supported by industry is being sponsored by the government in all these directions. A symposium on computer tubes will be held in December under the auspices of the Defense Department's Panel on Electron Tubes, the IRE, and AIEE; one purpose of this conference will be to bring together the user and the manufacturer in the hope of securing better tubes for computer uses through selective standardization.

We are now entering the period when attention is being given to the building of special-purpose digital machines. Already Northrop Aircraft, Inc., has developed the MADDIDA, a digital differential analyzer using a magnetic drum memory. The block diagram of the solution of a differential equation on the MADDIDA is similar to that of the same equation on an analog differential analyzer, but the amount of equipment is impressively small. This machine gives promise of important uses not only in its present form but in projected extensions of that form.

In the early discussions of very high-speed computers, great emphasis was placed on the need to develop a machine that would accept a small amount of information, perform very rapidly extensive operations upon this information, and turn out a small amount of information as its answer. Problems of this sort are surely no less critical today than they were five years ago. In this area lie many of the really difficult problems of mathematical physics.

Current interest, however, seems to lie in a further exploration of the use of machines to accept large amounts of data, perform very simple operations upon them, and print out, possibly, very large numbers of results. Some special-purpose machines of this sort are under discussion. The Department of the Air Force is planning to ask the Bureau of Standards to design a machine especially adapted to the determination of optimum programs for the Air Comptroller. This machine must be capable of handling extremely

large matrix problems. In addition the Air Force is planning to study the special requirements of its statistical control and statistical research centers and to proceed with development of a moderate-size machine intended for such applications. Both the machine for computation of optimum programs and that for statistical operations will require printing out of large amounts of information, and in this connection a prototype model of a very high-speed printer has been developed.

Much has been said about the critical urgency of developing qualified personnel to handle the digital machines as they go into operation. Some of the lessons learned at Aberdeen and Dahlgren in the operation of their computers are: (1) Human error causes considerably more trouble than machine error. Errors in coding and in the setting of dial switches have been a frequent source of irritation in the operation of the Aiken Relay Calculator at Dahlgren. (2) There is need for a simplification of coding procedures. Even for very small calculators, the time required for coding problems has often been considerably greater than the time required for solution on the machine. Surely in the programming and coding of problems we must improve the competence of the operating staff to a very considerable extent.

There is also an important need to explore more fully the mathematical formulation appropriate to the types of problems that arise frequently in applications. The highly competent staffs at Aberdeen and at Dahlgren have been impressed by the extensive difficulty of determining even approximately optimum formulation of their problems and of relying on existing mathematical proofs to assure the convergence of various processes they have had to use. Thus there remains an important creative area for the mathematician in facilitating and implementing the uses of digital machines.

A small attempt at meeting this need is being undertaken by the Office of Naval Research through its support of work in numerical analysis related to the use of digital computers at the Institute for Advanced Study at Princeton, and at the Institute for Numerical Analysis of the Bureau of Standards. But until more machines come into operation, and more practicing scientists experience difficulties in solving their own problems, we must expect that significant progress will be slow. I believe that as the new computers become available to research workers we shall enter a new and exciting period in scientific research, to which physical scientist, mathematician, and engineer have much to contribute.

Building an Effective Technical Library

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SCIENTISTS AND ENGINEERS for the most part are not concerned with the question of why they need a technical library in their work. Their reaction to such a question would probably be one of surprise, since "everybody knows" that a technical library is necessary in scientific and engineering pursuits. The "why" is a question that concerns the scientist or engineer only when he assumes administrative responsibility for a research and development program. Then he finds he not only must know why but also must be acquainted with the what, when, where, and how (which usually becomes how much). This paper is an attempt to point out the factors to be considered in establishing an effective library for a scientific or technical organization.

Size and Scope

To determine the type of library best suited to the organization, it is necessary to consider the nature of work performed, as the library reflects the subject interests of the organization as a whole. An activity engaged in basic research, for example, would need a much more extensive library than a testing facility, since the former covers broader subject fields.

The size of the library is dependent upon five principal factors: the number of subject fields to be covered, the extent to which each subject is to be covered, the number of people in the organization served by the library, the total budget of the establishment, and the proximity of the library to other technical libraries. In a metropolitan area the library could be quite small, as library materials could be obtained through arrangements with other libraries, possibly even on a contract basis. In areas not close to existing libraries, it is, of course, necessary to build up more complete and self-sustaining collections. The library might range from the storehouse type of collection with its "bookkeeper," to the maximum of a large, diversified collec-

tion of background, as well as current, materials serviced by a staff of professionally trained abstractors, bibliographers, translators, and even subject specialists, assigned as liaison agents to work on projects with the technical and scientific staff. The average library would fall somewhere between these extremes.

If the library is merely a storehouse for technical information, tended by one or two custodians, the scientist or engineer must be prepared to consume valuable hours of his time searching for material he needs. He may find it or he may not, but it is fairly certain he will not find everything that is pertinent to his particular inquiry. And the more material added to this custodial type of library, the harder it becomes to find specific items. The larger library, whose role is not merely passive custody of material, will have staff members who, by reason of their training and experience, can anticipate the library needs of the scientist or engineer. These staff members can call attention to information pertinent to the work of particular scientists or engineers; they can catalogue and organize the library collection to coincide with the subject interests of the organization; and they can prepare bibliographies and reading lists in anticipation of projects requiring background studies of the technical literature. The concept of size of a library, then, includes both the number and kind of professional services required of the staff, as well as the amount and variety of the library materials.

In deciding the size and scope of the library, one has to understand fully the potential value of the library to the organization. The library should not be developed out of proportion to the other supporting services or beyond the actual needs of the whole organization, but, on the other hand, it should not be assigned an inferior role that would hamper its effectiveness. Underestimating the value of the library results in inadequate and inferior library service. The place of the library in the organizational hierarchy should be commensurate with present and potential degrees of responsibility. The success of the library program depends heavily on such visible manifestations of support from management.

Cost

Assuming that it may be desirable to develop and operate a library for a technical establishment, then a logical question is, How much will it cost? Some estimates on library costs are presented here to show the order of magnitude of expenditures to be expected. These estimates are not intended as recommendations for optimum budgets, but are presented to indicate what cost can reasonably be expected. Three aspects are considered: basic investment, current operating cost, and comparisons of cost.

The principal costs on the initial establishment of a library are for salaries, books, periodicals, equipment, supplies, furniture, and housing. The average cost of technical and scientific books is about $5.00 a copy. Technical periodical subscriptions average about $7.50 per year. Adjustable steel book shelving costs $1.50–$3.00 per linear foot of shelf space, not counting installation costs. Steel filing cabinets cost $75.00–$90.00 each. The cost of conventional office furniture, typewriters, etc., is not included here because the figures are readily obtainable. Space for the library is an item of cost in the sense that the establishment has a certain amount of total usable floor space to be allocated among its several divisions, including the library. Thus, the organization must get full value for all space allocated to any of these divisions or groups.

By using the unit costs listed above, one can easily estimate the total cost of establishing a library whose size and scope have previously been determined. To take a hypothetical case as an example, the cost of establishing a basic library for an electronics development activity, remote from other library facilities, with a total staff of 400 people, and an annual budget of $3,500,000, can be based on the following estimated requirements: 6,000 books ($30,000), 200 current periodical subscriptions ($1,500), and 1,000 back volumes of periodicals ($10,000) would give excellent coverage in the fields of mathematics, physics, and electronics. Equipment and supplies would cost an additional $6,000, mostly for shelving and furniture. This means a *basic* investment of $47,500 in books, periodicals, and equipment. Approximately $25,000–$30,000 for a library staff of seven or eight people should be added to this total. After a year or two, when the extra initial work is completed, this staff can be reduced to five or six people to handle the work on a current basis, and the cost of salaries reduced to about $20,000.

Current operating costs can be obtained by using the same unit cost figures. In the example cited, it would cost about $7,500 a year to keep the collection up to date, about $500 per year for equipment and supplies, and about $20,000 for salaries—a total of $28,000 per year. The initial cost of the library represents about 2 per cent of the total budget of the organization for the first year or two and about 1 per cent thereafter, for current operating costs. A survey of college and university library operating costs indicates that these institutions spend on the average about 4 per cent of their total budgets on their libraries (*1*).

Value Received

Obviously the library provides a means for obtaining all sorts of technical information quickly and efficiently. The library also helps the scientist or engi-

neer keep up to date in his special field. Moreover, wasteful duplication of research already reported in the literature can be avoided if published results of previous investigations are consulted prior to starting a project in the laboratory. Once the organization has a library, the scientist or engineer need not be limited to the use of materials in his own library, since he may obtain access to the collections of other, more complete libraries by means of interlibrary loans. All these things the library does for the purpose of preserving and transmitting ideas, so that science may progress without needless duplication and retrogression.

These values are obtained as a result of the work of the library staff, whose education and experience are brought to bear on the problem of organizing information in a systematic manner. But there is more to operating a library than meets the eye. A library is like an iceberg: the visible portion is only a small fraction of the whole. The library user has no contact with the two thirds to three fourths of the staff who work on the acquisition, cataloguing, and indexing of publications. In many libraries the patron never sees these workers. Not seeing them, he quite logically assumes that the librarians in the reference room and at the loan desk constitute the whole force. Even if he does see a room full of cataloguers, he probably wonders what on earth all those people are doing. They are working to make it possible for him to find what he wants in the reference room and at the loan desk. These behind-the-scenes workers search, select, order, borrow, and receive publications that are needed now or that may be used in the future. Then they catalogue, classify by subject, index, cross-reference, record, and file the material received. This is complicated and difficult work, filled with endless detail, and requiring a high degree of skill, training, and experience for its successful performance.

The caliber of personnel doing this work determines the degree of effectiveness of the library. As qualified technical librarians are in great demand, the organization must be prepared to offer salaries commensurate with the training and experience required. In a technical library the head librarian must have a background in scientific and technical fields, plus a good foundation in librarianship and adequate experience in administration and personnel work. These points were discussed in an excellent article on science librarianship by Judith Wallen Hunt in SCIENCE (*2*).

The technical librarian, experienced in organizing information and handling technical publications, can provide the individual scientist or engineer with an effective means for obtaining the information he requires. Technical literature pours off the presses at such a rate that no one can possibly cope singlehanded with the problem of digesting and organizing for future use the information pertinent to his work. For example, a recent study of physics abstracting sponsored by the American Institute of Physics listed 145 abstracting services of physics interest (*3*). Each of these services indexes and abstracts an average of about 6,500 periodical articles per year, which amounts to a combined total of almost a *million* abstracts! Confronted with such tremendous masses of material, the research worker certainly needs the facilities of an adequate technical library and the assistance of experienced librarians, as anyone who has used an inadequate library well knows.

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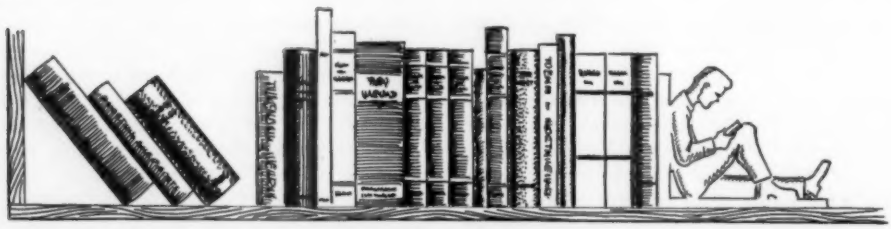

Dennis Robert Hoagland: 1884–1949

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DENNIS ROBERT HOAGLAND, professor of plant nutrition in the University of California, distinguished plant physiologist, and the world's leading authority in the field of plant and soil interrelations, died in Oakland, California, on September 5, 1949. For more than thirty years, Professor Hoagland's life and work exerted a profound influence on the evolution of plant and soil science in America and abroad. But, as with most great men, the totality of his achievement is greater than the sum of his impressive individual contributions. He personified the qualities of mind and character that led some to observe that the scientist with a broad outlook on his work and the world around him is among the finest products of Western civilization.

D. R. Hoagland spent his first eight years in the town of his birth, Golden, Colorado; his later childhood was passed in Denver, where he received his primary and secondary education. During his high-school days he first acquired a definite interest in science, in his own words "as a result of discussions of the theory of evolution which was condemned at that time by many ministers of the city: my thinking was greatly stimulated by the ideas and points of view of biology with regard to man's place in nature."

Hoagland left Denver to enter Stanford University, where he elected chemistry as his field of study. Upon his graduation in 1907 he was elected to Phi Beta Kappa and to the Chemistry Honor Society (now Phi Lambda Upsilon). After graduation he undertook graduate work in chemistry at Stanford, but in January 1908, he took a fateful turn in his career by accepting a position as an instructor and assistant in the laboratory of Animal Nutrition at the University of California. The new position brought him for the first time into professional contact with biology and took him to Berkeley, where, except for a few short gaps, he was to spend the rest of his life.

Hoagland remained in the field of animal nutrition and biochemistry from 1908 to 1913. In 1910 he joined the Consulting Referee Board of Scientific Experts of the USDA, an assignment that took him to Philadelphia. After the completion of the work of the Referee Board in 1912, he accepted a graduate scholarship to work in animal biochemistry with E. V. McCollum in the Department of Agricultural Chemistry at the University of Wisconsin. In later years Hoagland looked back on the year of graduate study under Professor McCollum as his real inspiration for a life devoted to scientific research. In 1913 he received his Master's Degree, and in the same year published with E. V. McCollum a series of three papers on the *Endogenous Metabolism of the Pig as Modified by Various Factors.*

In 1913 Hoagland had thus completed a period of five years of continuous work in animal nutrition, and there would normally have been every expectation that he would continue in this field, which was then on the eve of revolutionary advances. Circumstances intervened, however, and he abandoned the subject in which he had already amassed considerable experience. For this, plant science will always remain indebted to John S. Burd, then head of the Division of Agricultural Chemistry, College of Agriculture, University of California. In 1913 Professor Burd invited Hoagland to come to Berkeley as an assistant professor of agricultural chemistry. His acceptance initiated his scientific activity in a field in which he worked with distinction till the end of his days.

The appointment in the Division of Agricultural Chemistry of the University of California was a real opportunity to one who had already acquired an attachment for fundamental research. The department was chiefly interested in problems of fertilizers and soil chemistry. Practical and immediate as these questions appeared, Burd had the vision to encourage the search for principles rather than *ad hoc* solutions.

The interruption of commerce in World War I focused attention on American dependence on German sources of potash fertilizers. There was considerable interest in exploring domestic sources of potassium, and the giant kelps of the Pacific Coast were suggested as a possible source of supply. Hoagland undertook a systematic study of the inorganic and organic composition of kelps. His conclusions as to the possibility of commercial exploitation of these organisms were not very encouraging, but this research led him into an investigation of the accumulation of ions by plants. He was impressed with the remarkable ability of kelps to accumulate potassium and iodine many times in excess of the concentrations found in sea water.

The second of his early research activities concerned itself with the effect of hydrogen ion concentration on plant growth. This was the era of "hydrogen ion concentration" in biology, when great expectations were centered around the introduction of the hydrogen electrode for the measurement of pH of biological systems. One of the accepted tenets of agricultural teaching in those days was that plants could only grow well at neutral or slightly alkaline reactions. It was with great surprise, therefore, that Hoagland discovered that barley plants made excellent growth in nutrient solutions at pH 5. It seemed that the chief importance of the hydrogen ion was in relation to other ions rather than in

its direct effect on the plant. It was also apparent that the inherent complexity of soils rendered untrustworthy many sweeping generalizations based on local conditions. It became clear that the complex problems of soil and plant interrelations must be studied by techniques that would permit rigid experimental control and the isolation of individual variables.

He gave expression to his convictions about the value of artificial culture methods in plant research by developing the water-culture technique for growing plants. Under the influence of the soil solution studies conducted by Burd, Hoagland devised a culture solution to imitate a soil solution obtained from a soil of proven fertility. "Hoagland's solution" became, and remains to this day, a "household" term in laboratories of plant physiology throughout the world. The formulation of his culture solution was accompanied by a study of certain basic concepts, such as concentration versus total supply of ions, specific proportions of nutrients and the like, which underlie the use of nutrient solutions. He critically examined and rejected the idea of an "optimum nutrient solution," a point of view fully corroborated by later work.

His early researches into plant and soil chemistry convinced him that the study of soil and plant interrelations could be pursued most auspiciously by a closer union between workers in soil chemistry and plant physiology. This opinion was given administrative sanction in 1922 by the organization of a Division of Plant Nutrition within the University of California College of Agriculture. Hoagland was designated its head. In the new division his major research interest became the absorption and accumulation of ions by plants. The quality of the immense contribution which he, with his collaborators and associates, made to this fundamental process of plant physiology can only be judged against a background of the ideas and concepts that prevailed when his work got under way. There was no clear view as to how inorganic elements are absorbed by plants. Discussions of this subject usually invoked such concepts as osmosis, permeability, antagonism, none of which, as he later demonstrated, could explain the absorption, accumulation, and retention against a concentration gradient of anions and cations by plant cells.

Hoagland opened the study of ion absorption by using intact barley plants. Promising as the early results were, he readily perceived the advantages of working with a unicellular organism from which relatively pure vacuolar sap could be obtained. At the suggestion of the late Nathaniel Gardner, he selected the fresh-water alga *Nitella*. This work clearly demonstrated that absorption of ions by plants is a metabolic process and not a question of simple permeability. For example, absorption and accumulation of bromide could take place in Nitella only under the right metabolic conditions—proper temperature and illumination. The accumulated ions were not precipitated in the sap but remained as free ions, the concentration of electrolytes in the Nitella sap being twenty-five times greater than that in the surrounding medium. Although the concept of "ion antagonism" had no strict applicability to the normal process of nutrient absorption, there was clear evidence of reciprocal effects of one ion on the absorption of another, as, for example, potassium on calcium and nitrate on phosphate. Here was painted in bold outline a theory which at once correlated a host of observations in the field and laboratory and made it possible to approach an infinitely complex subject with principles instead of mere empirical observations.

The next important phase of his researches on ion accumulation brought him closer to the problem that was uppermost in his mind—the absorption of nutrients by the roots of higher plants. In its solution, Hoagland displayed his remarkable gift for resolving a complex question into its essential components and arranging them unerringly in an order of relative importance. Though a chemist by training, he early acquired the outlook of a biologist and was mindful of the inherent complexity of biological systems and their adaptivity to varying conditions; hence he distrusted the spectacular short-cut or facile generalization unless it was supported by solid experimental evidence. As far as salt absorption by roots was concerned, he decided in the late 1920s that the most important prerequisite for future work was the development of a technique that would make available biological material of a definable and reproducible physiological status. Only in this manner could the various conflicting observations be resolved and a systematic effort directed toward the elucidation of unknown factors.

He concluded that the fundamental questions of ion absorption by root cells can be studied most effectively by eliminating the complications of shoot and root relationships. He concentrated, therefore, on excised roots obtained from plants grown under experimental conditions designed to yield, subsequent to the removal of shoots, root systems with a high capacity for salt absorption. Among the essential conditions for a high capacity for ion absorption by roots were a low salt and a high carbohydrate status. Under these conditions the excised roots were found to be "the most active salt-accumulating system so far [1936] investigated."

Once the tedious but indispensable job of evolving a suitable physiological technique was completed, progress was rapid and gratifying. An impressive array of data was amassed over the years on the influence of temperature, light, hydrogen ion concentration, ion selectivity, concentration of anions and cations, differences in rates of absorption, and the effect of one ion on the absorption of another ion of the same or opposite charge. A striking correlation was obtained between the supply of oxygen and the absorption of salts by roots against a concentration gradient. A solid scientific foundation was thus laid for the understanding of the importance of aeration in soils and for the interpretation and prediction of a multiplicity of plant responses to fertilization treatments, and other chemical changes in the soil.

The final phase of Hoagland's investigations on absorption of ions occurred just before and during World War II. With excised barley roots he studied the effect of reversing the external concentration gradient on ion

entry and the influence of inhibitors on ion accumulation. He returned to Nitella, this time employing radioactive isotopes—a sensitive technique that permitted the separation of the two stages of ion absorption by cells: from the external medium into the cytoplasm, and from the cytoplasm into the vacuole. The fundamental conclusion, which he and his colleagues reached almost two decades earlier, that ion accumulation is a metabolically linked process, was confirmed. With the use of radioisotopes it was possible to show that ions first accumulate in the cytoplasm, but that subsequently they migrate to the vacuole by a process akin to secretion, until the vacuolar concentration becomes higher than that in the cytoplasm and decidedly higher than that of the external dilute solution.

Dominant as his lifelong interest in the process of ion absorption was, it by no means prevented him from pursuing with vigor other phases of plant nutrition, to which he, with his associates, made outstanding contributions. He studied the upward movement and distribution of inorganic solutes in the plant. In the late 1930s, when radioactive isotopes from the cyclotron became available, he used them in resolving some of the hitherto perplexing uncertainties as to the path of ion movement in higher plants. In a series of experiments on the relation between the movement of solutes and absorption of water by plants, he again demonstrated the extent to which the two are related to, as well as independent of, each other.

Hoagland was keenly aware of the immense importance for physiological studies of the control of light, temperature, and humidity, as well as of the culture medium. He was instrumental in securing an installation for the control of environmental factors in Berkeley, one of the first in America. He envisaged "the development of a quantitative plant physiology in relation to mineral nutrition when it will be possible to do exactly the same thing twice."

Preoccupation with precise laboratory experiments and insistence on an exact though "artificial" culture condition in no way diminished his appreciation of the importance of direct studies on soils and on crops grown in soil. In his own words,

> Viewing the field as a whole, the attack on problems of plant nutrition assumes wide dissimilarity of method. At one time, the appropriate tool may be a spade or a soil auger; at another time a highly specialized and refined tool of physics or chemistry may be required. For some purposes, crude measurements in terms of pounds or ounces may suffice; for other purposes, a thousandth of a milligram or even much less than that is of consequence.

His own work on problems of soil chemistry insofar as it affects the nutrition of crops grown in the field was especially concerned with zinc, potassium, and phosphate deficiencies of fruit trees in California. He contributed to the identification of one of the most important physiological diseases of fruit trees in California—"little leaf"—with zinc deficiency, and reproduced it under controlled greenhouse conditions. His investigations of potassium nutrition had a bearing on "prune dieback," another nutritional disease of fruit trees in California, and led to extended studies of the chemical aspects of potassium availability in soils. His interest in the nutrition of fruit trees continued, and in 1940 he produced, under controlled conditions, the first molybdenum-deficiency symptoms in a fruit tree species.

In summarizing Hoagland's contribution to plant nutrition, it is pertinent to record that he did not regard the field as a unified discipline. In his own words, "An essential condition in the field of study of Plant Nutrition . . . is the uniting, although not according to any rigid pattern, of persons of varied technical interests, in a research program that has a common objective." Although he himself was mainly engaged in studies of the mineral nutrition of plants, he was keenly aware of the importance of the biochemical aspects of plant nutrition. Under his leadership the Division of Plant Nutrition became an outstanding center of research, encompassing a diversity of investigations seldom encountered within the confines of a rather small administrative unit. His scientific influence was not confined to the numerous graduate students who sought the privilege of associating with him; it included many mature scholars and colleagues from all parts of the world who came to work in his laboratory at Berkeley.

Hoagland's entire life as a productive scientist was spent in association with agricultural research. He had a profound faith in the importance to agriculture of fundamental research, without thought and expectation of immediate practical returns. He was fully aware of the often wide gap between the laboratory result obtained under controlled conditions and field application. In dealing with living plants and animals he was mindful that "it still takes the wheat plant six or nine months to develop and cows bring forth their calves neither more quickly nor more numerously for us than they did for Abraham." He believed that the contribution of science to agriculture must be judged not only by its material achievements but also by the enlightenment it proffers to the farmer and city dweller alike.

As an administrator, Hoagland was anxious not to fritter away his time and energy on the minutiae of scientific housekeeping and administrative procedure but sought to discharge his responsibility to the university by concentrating on the encouragement and development of the broad aspects of his field of science. In relations with his colleagues, young and old, he always comported himself with the courtesy and understanding of the true scholar for the scientific interests and activities of others. He was singularly free from any notion that notable advances in fundamental knowledge can be attained by administrative direction.

He was an ideal collaborator in scientific research, never seeking dominance for his own point of view but always inviting a free flow of ideas. He was meticulously careful in giving credit where credit was due and was generous in acknowledging the contributions of his associates. He was a master of clear exposition and had a real feeling for style, but he always preferred to defer publication of results until the evidence was carefully assembled and checked.

Hoagland's chief characteristic, whether in scientific matters or in personal relationships, was integrity and objectivity of outlook. In evaluating scientific evidence he had the "four things" which Socrates said "belong to a judge: to hear courteously, to answer wisely, to consider soberly, and to decide impartially." He applied the same critical standards to his own work as to that of others. He accepted no blanket authority in science and expected every single piece of research to stand on its own merits regardless of its source. In personal relationships he possessed the engaging quality of always seeking the good in men and their work. In approaching students he had a rare gift of making them sense the good will and confidence in their ability with which he always credited them at the start. His students were spurred to special efforts by a desire to prove themselves worthy of his trust. Hoagland's confidence and friendship once given were not easily withdrawn. Never demonstrative in manner, he had a deep loyality and an unfailing concern for the welfare of his friends and associates.

Hoagland carried the scientific mode of thinking outside his own specialty into diverse areas of human thought and achievement. He maintained an active interest not only in many departments of science but also in fundamental questions of education and in the social and political problems of the contemporary scene. It was a stimulating experience to witness his well-stocked mind analyze a complex issue with clarity and insight that unerringly penetrated to the root of the matter. In the seventeen years during which I was associated with him as student, colleague, and friend, I never once heard him discuss a person or an issue, scientific or otherwise, except in a fair and objective manner.

It is only natural that his accomplishments, his qualities of mind and character, should gain him wide recognition and many honors. His counsel was sought and valued within his own university, to which he gave unstintingly of time and effort in many arduous administrative assignments, usually at the expense of his own leisure and in later years at the expense of his health. In 1934 he was elected a member of the National Academy of Sciences. The American Society of Plant Physiologists, which was his closest scientific affiliation, bestowed upon him its highest honor by granting him, in 1929, the first Stephen Hales Award in recognition of his outstanding research contributions. He was also elected president of the society and occupied other important offices in it. The high esteem in which he was held by plant physiologists throughout the world is attested by his appointment as president of the Section of Plant Physiology at the VIIth International Botanical Congress in Sweden this year. Unfortunately, poor health forced him to decline this international honor.

Many other societies in which he held membership honored him by election to their presidency: Western Society of Soil Science (1924); Western Society of Naturalists (1931); Botanical Society of America, Pacific Division (1929); American Association for the Advancement of Science, Pacific Division (1941). He served as consulting editor for *Soil Science* and took a prominent part in the organization of the *Annual Review of Biochemistry*, serving from its very inception on the Advisory Board and, later, on the Board of Directors of *Annual Reviews*. He was a member of the Board of Collaborators for the U. S. Department of Agriculture Salinity Laboratory at Riverside, California, and the Soil, Plant and Animal Nutrition Laboratory at Cornell University.

In 1940 the American Association for the Advancement of Science awarded him its $1,000 prize for the outstanding paper presented at the Philadelphia meetings. In 1942 he was invited by Harvard University to give the John M. Prather lectures. The lectures were later published in book form and constitute the only book that he found the leisure to prepare. His own colleagues in the various faculties bestowed upon him the highest honor within the university by appointing him faculty research lecturer in 1942.

Hoagland was never in robust health, but a strong sense of duty compelled him to work without a thought for his own personal well-being. The last four years of his life were marred by serious illness, but he carried on with courage and determination to within the last few months of his life, when his eyesight failed him almost completely. This latter blow was the severest of all, for throughout his life he enjoyed reading on a wide variety of subjects. It was characteristic of the man that once he gave up hope of regaining his health, he requested retirement from the university, ignoring the serious financial adjustment that such a step would involve. He was officially retired on July 1, 1949, and died two months later.

In 1920, he married Jessie A. Smiley, who died in 1933, leaving him the responsibility of bringing up three young boys. His three sons, his mother, and a brother survive him.

The scientific influence of Professor Hoagland's life has not come to an end with his death, but will continue through the deep impression it has made on the minds and hearts of his students and friends.

Technical Papers

A Thermophobic Insect[1]

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Recent interest in the physiology of organisms known to be tolerant to relatively low temperatures (*1*) prompts me to report observations made in 1948 concerning the life history of the stonefly, *Nemoura columbiana* Claassen (order Plecoptera).

Stoneflies were among the first adult insects observed to be active in the vicinity of Anchorage, Alaska, during the spring of 1948. Specimens of *Nemoura cintipes* Banks and *N. columbiana* Claassen (identified by W. E. Ricker) were taken as early as April 9. They continued to emerge from the smaller streams as rapidly as the ice covering the streams broke up.

On April 19 a stream on a mountainside 17 miles northeast of Anchorage was examined. It was entirely frozen over for one-half mile below the point where the stonefly observations were made. Higher up, the stream flowed down a precipitous slope through a channel buried deep beneath a series of ice cascades. Along the lower part of the stream, water could frequently be heard flowing beneath the ice, and at such places holes were cut so rocks could be withdrawn and examined for black fly larvae.

A short distance below the ice cascades a hole was cut through 1 ft of snow and 2 in. of ice. This hole was found to open into an ice cavern that had been eroded in the ice immediately over a riffle in the stream. On the ceiling of the ice-enclosed cell were 2 mating pairs and 19 individual specimens of *N. columbiana* Claassen. Three individuals were seen to fly out of the hole and land near by on the snow, where they crawled actively about.

The temperature of the water in the stream and of the air inside the cell was 32° F. The air temperature outside was 30° F. An overcast sky minimized any chance that the dark-bodied insects might be warmed to some extent by solar radiation. These insects appeared to be conducting themselves normally and enjoying full use of their body functions at a temperature of 32° F. The ice covering this part of the stream did not break up until about 10 days later, and had the insects been left undisturbed there is good reason to believe that they could have deposited eggs and died without escaping into the open air.

Weekly temperature records were kept for this stream from April 19 through October 26. The highest temperature recorded was 44° F, and the average of all records was 38.03° F. From these stream temperature records, and the observations concerning the adults, it would appear that these insects have a remarkable capacity for growth and function at temperatures that are continuously near the level at which development of most insects ceases.

In view of the well-known tendency of poikilothermic animals to prolong their period of development when subjected to temperatures below optimum, it might be expected that *N. columbiana* and related species of *Nemoura* would require more than one season to complete their development. Available evidence (*2, 3*), however, indicates that the species of *Nemoura* have one generation a year. If this is true, these insects should prove worth-while subjects for study by workers interested in the physiology of organisms living under conditions of quite low temperature.

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[1] These observations were made incidentally during the course of studies concerned with the biology of Alaskan black flies. These, and associated investigations, were conducted by the Bureau of Entomology and Plant Quarantine, USDA, under a transfer of funds from the National Military Establishment.

The Effect of Reinforcement History on Extinction after Reconditioning

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This paper deals with an experiment to determine whether extinction to operant (preconditioning) level is permanently effective in eliminating differences in response strength among groups given varying amounts of original conditioning. Resistance to extinction after a constant amount of reconditioning was used to test the effectiveness of the preceding "complete" extinction. Nearly all reported studies of reconditioning have clearly involved only partial interpolated extinctions, as in periodic or aperiodic reinforcement (*1–4*). Two reported experiments in which a criterion of complete extinction was met (*5, 6*) were concerned with avoidance conditioning, and are, thus, not directly pertinent to the present study. Nevertheless, in one of these (*6*), the data for

[1] Postdoctoral fellow, National Research Council, 1950.

[2] Postdoctoral research fellow of the National Committee on Mental Health, USPHS, 1950–51.

TABLE 1

SUMMARY OF DATA

(The asterisked values in extinction are performances on the first criterion day)

GROUPS	Control (N = 8)			I (N = 5)			II (N = 6)			III (N = 7)			IV (N = 7)		
Number of reinforcements in original conditioning	0			12			30			65			125		
	Mean	*Median*	*σ*	*Mean*	*Median*	*σ*	*Mean*	*Median*	*σ*	*Mean*	*Median*	*σ*	*Mean*	*Median*	*σ*
Operant level (based on days 5 and 6)	20.3	20.0	11.1	21.4	20.0	10.9	23.5	21.7	14.3	19.4	18.0	11.3	21.6	14.5	15.4
Daily responses during extinction after original conditioning															
Days															
1	37.0	35.5	13.6	29.8*	26.0*	18.6*	72.8	69.5	15.0	81.0	82.0	17.7	90.7	97.0	33.0
2	34.5	33.0	14.3				45.5	30.5	20.1	47.9	40.0	13.5	73.0	68.0	41.5
3	33.8*	32.0*	23.4*				39.8	32.0	19.3	36.7	34.0	13.8	58.9	62.0	10.8
4							34.7*	31.0*	18.2*	26.3*	24.0*	7.3*	44.6	44.0	12.8
5													51.1	48.0	31.8
6													50.9	50.0	23.5
7													40.4	41.0	18.9
8													43.7	50.0	19.4
9													35.0*	34.0*	20.4*
Daily responses during extinction after reconditioning															
Days															
1	55.3	55.5	20.6	35.8	39.0	15.9	53.7	44.0	24.5	50.1	44.0	18.3	50.4	37.0	42.5
2	33.7	33.0	14.9	23.4	21.0	8.3	50.1	35.5	36.0	34.7	32.0	11.7	39.7	28.0	28.2
Total (Days 1 + 2)	89.0	88.0	33.1	59.2	54.0	22.5	103.8	81.5	50.9	84.8	73.0	23.7	90.1	67.0	70.2

extinctions following successive reconditionings show no tendency for resistance to extinction to increase.

The subjects of the present experiment were 40 male albino rats, Wistar stock, 100–120 days old at the start of experimentation. These were divided into 5 groups of 8 rats each. Subsequent deaths reduced the size of the groups to the *N*'s given in Table 1. The apparatus consisted of living-experimental cages, response levers, and recording devices as described by various authors (*2*, *7*, *8*). The general experimental conditions were those detailed by Notterman (*2*). The entire experiment was performed on consecutive days.

Three days were used to begin the establishment of a hunger rhythm, involving 23¼ hr of deprivation and 45 min of feeding. Starting with the fourth day of rhythm, operant level sessions of 45 min duration were given on each of the next 6 days. They served two main purposes: To ensure that the experimental groups were not significantly different in pretraining bar-pressing activity, and to provide a criterion for "completeness" of later extinction (*9*). For the experimental groups there followed 5 consecutive days of conditioning with regular reinforcement. On day 1, 10 pellets were dropped singly by the experimenter into the food tray to train a tray-approach response at the sound of a falling pellet. The bar was then inserted, and each bar depression was reinforced with a pellet until the animal had received ⅕ the total number of reinforcements allotted members of his group. On each of the 4 subsequent conditioning days, animals were again given ⅕ their allotted total of reinforcements for bar pressing. Groups I, II, III, and IV were assigned totals of 10, 30, 65, and 125 reinforcements, respectively. The training for the control group involved no bar-pressing, but consisted entirely of the delivery of pellets singly and at intervals of about 30 sec to the food tray. Each pellet delivery was, however, preceded by a bar-click, produced by the experimenter. Thirty-five pellets were delivered on day 1, and 25 pellets on each of the next 4 days. The daily schedule of pellet delivery was thus the same as the schedule of bar-pressing reinforcements for Group IV.

After the last conditioning session, daily extinction sessions of 45 min duration per animal were begun. For each group (including the control), extinction lasted until 3 out of 4 successive sessions failed to yield bar-pressing totals significantly greater (at 0.05 level) than that group's operant level. To obtain an operant level criterion, the responses made by each animal on days 5 and 6 of the operant level phase were averaged, and group means were then obtained (*9*). On the day after a group had met its criterion, reconditioning took place. Ten pellets were dropped singly and at intervals, as before, into the food tray to reinstate tray approach, and, after insertion of the bar, pressing responses were regularly reinforced until 15 reinforcements had been given. Extinction was then resumed for 2 days, with one 45-min session per day.

The data are summarized in Table 1. As indicated there, operant level was approximately the same for all groups, in spite of the previously mentioned loss of animals. Means and medians are also presented for daily response totals obtained during extinction after original

conditioning. The asterisked values for each group are those for the first criterion day. Thus, only one value is recorded for Group I, since it failed, even on extinction day 1, to give a mean response total significantly higher than its mean operant level. The effect of varying the number of reinforcements during original conditioning is seen, for example, in the extinction day 1 means. The values for Group II, III, and IV are significantly higher (0.01 level) than those for the control group and Group I, though they fail to differ significantly (0.05 level) from one another. There is little doubt that Group IV had acquired considerably greater response strength as a result of original conditioning than had the other groups. For 8 successive days of extinction it gave a mean response total significantly greater (0.05 level) than its mean operant level. This may be compared with 3 days for Groups II and III, 2 days for the control group, and no days for Group I.

That the control group gives values significantly higher than its operant level on extinction days 1 and 2 may be ascribed to (1) an increased tendency to remain in the food tray area where the lever was situated, and (2) the secondary reinforcing power acquired by the bar-click through repeated correlation with the delivery of pellets.

At the bottom of Table 1 are presented the means and medians for each of the 2 extinction days that followed reconditioning, as well as for the 2-day totals. Neither the daily nor the 2-day values yield significant (0.05 level) differences. The lower values for Group I may be related to the relatively low response level it had reached by the last of the criterion sessions (not shown in Table 1).

Thus, significant differences obtained during the first extinction fail to reappear during post-reconditioning extinction. Nor is any trend discernible. Accordingly, the tentative conclusion of the study is that "complete" extinction to operant level tends to eliminate permanently differences in response strength produced by varied histories of reinforcement. That all effects of previous conditioning may not be lost, however, is suggested by the report that successive reconditionings require progressively less time and fewer trials (*5*, *6*). The present finding, if valid, permits the use of experimental designs based upon the assumption that extinction to operant level removes the effects of differential intergroup exposure to such independent variables in acquisition as number of reinforcements and, possibly, amount of reinforcement (*7*).

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Microscopic Structure of Carrot Chromoplasts

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Carotene appears inside carrot cells in regular, crystalline bodies, the nature of which has remained uncertain until recently. Following the studies made by P. Fritsch (*1*), A. Meyer (*2*), W. Schimper (*3*), and M. Courchet (*4*) of these red particles inside the cells, the carotene bodies were considered by most botanists to be carotene crystals formed by plastids. Nothing, or at least very little, of the plastid substance was believed to have remained combined with the carotene bodies. This opinion was based not only on the crystalline form of the particles, but also on their cytochemical properties. For, when carrot slices are treated with lipid solvents on a microscopic slide, the red bodies can be seen under the microscope to dissolve, and no residue, or only an insignificant amount, remains. Recently T. E. Weier (*5*) again undertook a detailed cytochemical study of the carotene bodies of carrots. He, too, thought that "the larger bodies are distinctly carotene crystals. There is some question as to whether the smaller ones are. . . ." Weier observed, however, that the pigment may be associated with starch grains and that it is then present in the cytoplasm surrounding the starch and does not always appear crystalline. Weier believed that this pigment-starch-cytoplasm complex was probably a plastid.

In 1939, while studying the physical state of the carotene in carrot juice, the author saw carotene bodies for the first time but did not regard them as carotene crystals (*6*). In 1942 and 1943 he attempted to isolate the red particles from carrot juice, but was only partially successful (*7*, *8*). Cytoplasmic granules of microscopic and submicroscopic size remained obstinately adsorbed to the carotene bodies during all steps of purification. Although most of the granules could be removed, a certain number of them still contaminated the final preparations. (Only now can it be recognized that the contamination with submicroscopic, cytoplasmic granules was much higher than had been estimated at that time.) The purest preparations made at that time contained about 5% carotene, 40% proteins, and 45% lipids (*8*).

Recently the author has been able to resume his study of these carotene bodies.[1] A new method has made it possible to separate the chromoplasts from almost all cytoplasmic granules, as may be seen in Fig. 1. The new preparations contain 20–50% carotene, varying with the season and perhaps other factors. Their chemical composition and other properties will be described later.

[1] I am greatly indebted to Jean Oliver, of the State University Medical Center at New York, for his having consented to my doing this work in his department. The work was performed while the author was engaged in a research project aided by a grant from the Commonwealth Fund.

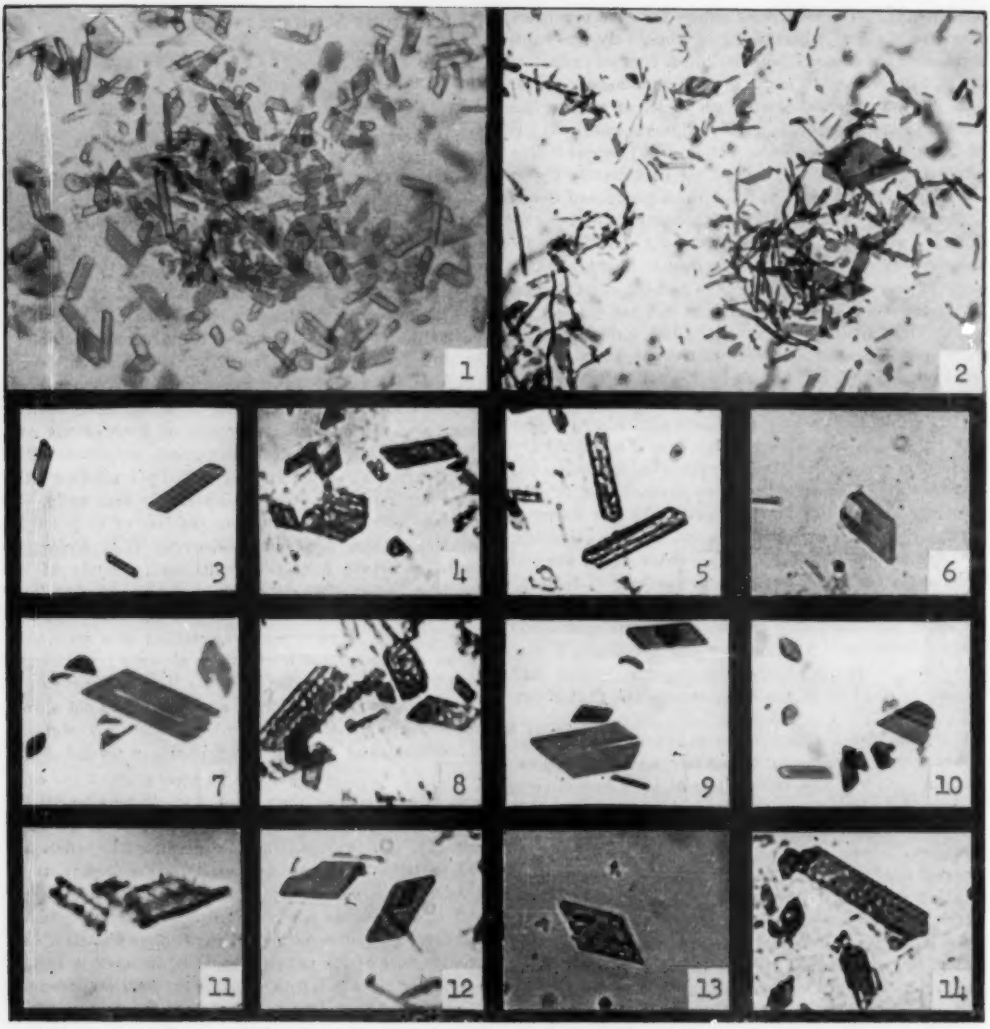

FIG. 1. 1, Isolated chromoplasts from carrots (×1250); 2, disintegration of chromoplasts into fiberlike fragments (×1350); 3, chromoplasts showing membranes (×1800); 4 and 5, disintegrating chromoplasts with parallel fibrils inside the body (×1800); 6, chromoplast with rectangular piece broken out of body (×1500); 7, disintegrating chromoplast with narrow, stripelike vacuole (×1800); 8, disintegrating chromoplast with stripelike vacuoles and fibrils (×1800); 9, chromoplast splitting into two pieces (×1800); 10, disintegrating chromoplast with rough stripes, indicating ends of layers (×1800); 11, part of stroma, stained by methylene blue, showing rows of grana (×2100); 12, chromoplast showing grana under layer of pigment (×1800); 13 and 14, disintegrating chromoplasts with tiny vacuoles (×1800).

It can now be understood why the carotene bodies were so easily mistaken for crystals of carotene. The pigment makes up a considerable portion of the whole particle, and is indeed present in crystalline form. Besides the pigment, however, the chromoplast contains still other ether-soluble substances, and the proteins of the "stroma" constitute a relatively small portion of the whole particle. That is why treatment with lipid solvents causes complete disintegration of the carotene bodies.

However, the stroma can be made visible by means of oxidizing agents, which destroy the pigment more quickly than the stroma. As described in 1943 (*9*), a fibrillar and reticular structure of granular appearance can be observed when the pigment has been oxidized by weak iodine solution. It is supposed that this protoplasmic framework, and not the carotene itself, is responsible for the regular form of the carotene bodies (*9*).

When chromoplasts disintegrate in aqueous suspension

or on a microscopic slide, they sometimes show characteristics that throw light on the structure of the stroma. In the following account, the structure of the stroma is discussed on the basis of those characteristics. For most observations, a drop of the chromoplast suspension (partially or completely purified) was dried on a microscopic slide, fixed over a flame, sealed under glycerol with paraffin, and examined after 6–12 months. It was found that the pigment had partially faded and that more of the underlying structure had become visible. A quick preparation of slides favorable for study of the stroma, and giving much better results than the above treatment with iodine, can be effected in the following way: a drop of the chromoplast suspension is dried on a microscopic slide, fixed over a flame, and the slide put in a beaker with water of about 90° C for ¼–1 hr. This treatment causes partial fading of the pigments and at the same time preserves the structure of the stroma, though it is probably altered through the heat.

Border fibers, fibrils. Chromoplasts in aqueous suspension often disintegrate spontaneously into many fiberlike fragments (Fig. 2).[2] The fragments show differences according to their origin from the border (peripheral) or inner part of the carotene body. This is related to the more pronounced organization of the stroma. For the stroma is more strongly developed in the peripheral portion as compared with the inner part (Figs. 1, 3). The border fibers (''rods'') preserve their fibrous structure when they are split off from the carotene body. However, the stroma in the inner part of the chromoplast is often too thin, or the covering layer of (crystallized) pigment relatively too thick, to preserve the fibrous structure. It disintegrates into fragments with irregular shape. In other chromoplasts, however, such as those in Fig. 2, the inner part of the chromoplast also has disintegrated into long, fiber like fragments. The contours of these fragments are mostly more irregular than those of the (straight) ''rods'' originating from the peripheral part of the carotene body. In Fig. 2, both kinds of fiberlike fragments can be recognized. Often the disintegration into such fragments can be provoked by boiling the chromoplast suspension for a few seconds.

Some of the chromoplasts seen in Fig. 1 (and in the other figures, also) do not show the marked border lines because the border fibers (''rods'') have been split off. The border fibers surrounding the whole carotene body are stained by basic dyes, and a blue rim can often be recognized around the body when partly faded chromoplasts are stained with methylene blue.

As was stated in the earlier paper (*9*), the fibrils are located in parallel alignment inside the carotene bodies. For the reason mentioned above, it is rare to find disintegrating chromoplasts in which the fibrils are well preserved inside the body. But sometimes, as in Figs. 4 and 5, fibrils remaining from the inner part of the stroma can be seen. The diameter of the fibrils, as estimated from Figs. 4 and 5, is 0.3–0.4 μ.

The following characteristics all indicate that the stroma has a regular structure in two directions, one perpendicular to the other, and parallel to the sides of the carotene body. In Fig. 6 a rectangular piece is broken out of the carotene body. In other cases the rectangular vacuole is found completely inside the body. In Fig. 7, the vacuole has the form of a long, narrow stripe parallel to one side of the chromoplast. This stripelike vacuole has approximately the same diameter as the fibrils (Figs. 4, 5), indicating that a fibril has fallen out of the carotene body seen in Fig. 7. The relation between stripelike vacuoles and fibrils can be well recognized in the disintegrating chromoplast of Fig. 8. In Fig. 9, the chromoplast shows a split from the periphery, parallel to one side. Perhaps the division of the chromoplasts *in vivo* occurs in a similar way.

Lamellae. Disintegrating chromoplasts often show one to three stripes parallel to one side of the body (*8*) (Fig. 10). This rough striation, not to be confused with the very fine striation through the fibrils, reveals the lamellar structure, each stripe marking the end of one layer. Under the microscope the thicker section ending with a stripe is more intensely red than the adjacent section. With dark-field illumination, a section delimited by a stripe appears of a different color from the adjacent section. The carotene bodies are so thin that only a few layers seem to be superimposed.

Sometimes giant sheets, or ribbons, measuring, for example, 40 μ × 12 μ, can be found. Their form might be compared rather with the green chromatophoric sheets and ribbons of certain algae than with ''crystals.''

''Grana.'' Fig. 11 shows a part of a stroma, pigment-free. (All other chromoplasts or fragments seen in Figs. 1–14 still contain a part of the red pigments.) As can be seen in Fig. 11, rows of tiny nodules or disks, ''grana,'' follow each other at regular intervals. From Fig. 11 the diameter of the grana can be estimated to be about 0.3 μ and thus to be at the limit of microscopic visibility. Sometimes the grana can be seen indistinctly and perhaps deformed by diffraction under the layer of pigment (Fig. 12). They seem to be located at regular intervals on the fibrils or in parallel rows on the lamellae. In focusing upon the grana a little differently, one can easily mistake the diffraction rings around them or the spaces between them as real structures. This happened to the author in earlier investigations (*9*).

Fig. 13 shows another characteristic of distintegrating chromoplasts which seems to be related to the grana: the presence of tiny vacuoles of approximately the size of the grana, which might be caused by the falling out of the grana. In Fig. 14, the vacuoles seem, rather, to represent free spaces between the grana.

More observations are necessary in order to determine the finer structure of the grana in the carotene bodies. It may be mentioned here that E. A. Roberts and M. D. Southwick (*10*) have observed ''protoplasmic entities'' in chromoplasts of carrots by electron microscopy. The structure of the chromoplasts recalls that which M. Menke (*11*) has seen in chloroplasts by examination under ultraviolet light. Menke mentions the possibility that the strong absorption of ultraviolet light by the grana of

[2] The "rods" found in the first preparations (7) were mostly formed by disintegration.

the chloroplasts may be due to nucleic acids. The grana of the stroma in Fig. 11 were stained by methylene blue. In other preparations, the grana seemed also to be stained by pyronine. This would indicate that the ribonucleic acid of the chromoplasts of carrots is located in the grana.

The author previously compared the carotene bodies of carrots with the inclusion bodies of virus-infected cells (*8, 12*). The present study further corroborates the possibility of this relationship. If our interpretation of the structure of the chromoplasts is right, the grana of the plastids can be compared to the chromomeres of chromosomes and to the chromidia which, according to Monné (*13*), form basic units of cytoplasmic fibrils.

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The Preparation of High-Purity Hydrogen Deuteride

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In connection with a project at the National Bureau of Standards on the precise measurement of properties of H_2, HD, and D_2 at various pressures, it was found necessary to prepare about 10 l of high-purity hydrogen deuteride. The reported purity (99%) of even the best preparation described in the literature (*1*) was deemed inadequate for the purpose, particularly since one series of experiments involved the measurement of the vapor pressures of binary mixtures of the isotopes; very high purity was needed in order to avoid the complication of having to deal with ternary mixtures. Accordingly, it was necessary to further purify the "crude" hydrogen deuteride as prepared.

A number of methods have been reported for preparing high-concentration hydrogen deuteride, all involving the decomposition of a deuteride or hydride with water or deuterium oxide, respectively. Thus, Beutler, Brauer, and Jünger (*2*) decomposed lithium hydride with deuterium oxide *in vacuo* and obtained a gas mixture rich in hydrogen deuteride, as determined by absorption spectrum measurements. Norton (*3*) prepared B_2D_6 from B_2H_6 and deuterium and decomposed the deuteride so obtained with water in sulfuric acid. This yielded a mixture containing 85% hydrogen deuteride. Wender and co-workers (*1*) decomposed lithium aluminum hydride with deuterium oxide at 0° C, yielding a product containing 99% hydrogen deuteride.

For this work, the last method discussed above was chosen, because of the ease of operation and the yields obtainable. The product of this reaction was then fractionated at liquid hydrogen temperature. The latter operation was conducted substantially by the technique used by Scott and Brickwedde in their separation of hydrogen deuteride from equilibrium mixtures of hydrogen, hydrogen deuteride, and deuterium (*4, 5*). A similar technique has recently been described by Clusius and Starke (*6*).

The crude hydrogen deuteride was prepared in an apparatus comprising a 250-ml, 2-necked (Claisen) flask connected by a ground-glass joint to a reflux condenser, which was in turn connected through cold traps to a diffusion pump and a bulb for collecting gas. Suitably placed stopcocks permitted evacuation or admission of air, or nitrogen, to any part of the system. Stirring was effected by means of a magnetic stirrer, thereby avoiding the possibility of leaks through a packing gland. Deuterium oxide was admitted to the apparatus by inserting a hypodermic syringe through a rubber septum attached to the free opening of the Claisen flask.

With this apparatus, the operative technique was as follows: About 150–170 ml of refractionated *n*-butyl ether was distilled from sodium into the Claisen flask. The theoretical quantity of lithium aluminum hydride required to make the desired amount of hydrogen deuteride was calculated from the equation for the hydrolysis (*7*):

$$LiAlH_4 + 4D_2O \longrightarrow LiOD + Al(OD)_3 + 4HD.$$

A 30–40% excess was used. The septum was fitted to the flask, the latter was attached to the reflux condenser, and the contents were frozen by means of liquid nitrogen. The system was then evacuated, and the reaction mixture heated to reflux under its own vapor pressure for about 1.5 hr. After this time, the mixture was again frozen, the system again evacuated, and the deuterium oxide added through the rubber septum, in 3 portions. In order to keep the reaction going at a reasonably fast rate, it was found necessary to use about 150% excess of deuterium oxide over that calculated from the above equation. The temperature of the reaction mixture was controlled by means of a liquid nitrogen bath. The bath was applied intermittently, the time of application being determined by the melting of the frost on the outside of the Claisen flask. In this manner, the temperature was held at about 0° or lower throughout the course of the reaction.

By this technique, 15 l of hydrogen deuteride was pre-

[1] The authors are indebted to V. H. Dibeler, R. B. Scott, and W. E. Gifford, all of the National Bureau of Standards. Dr. Dibeler carried out the mass spectrographic analysis, and the apparatus in which the crude hydrogen deuteride was prepared was his. Messrs. Scott and Gifford assisted in the first of the series of distillations that comprise this work. Analyses were made by the Mass Spectrometry Section of the National Bureau of Standards, under the supervision of F. L. Mohler.

pared, in 2 runs of 5 l and 10 l. The purity, as determined by mass spectrographic analyses, was 98.1% and 97.0%, respectively.

Thirteen liters of this material was fractionated at liquid hydrogen temperature in 3 batches. The still was that employed by Scott and Brickwedde in their earlier

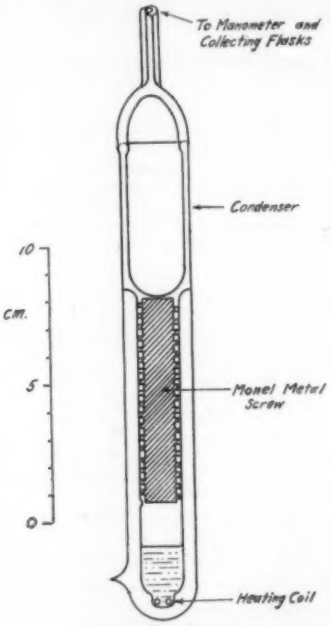

FIG. 1.

work (Fig. 1). It consisted of a boiler of about 5 ml capacity, a monel helix rectifying section, and a cold-finger type dephlegmating condenser. The boiler and rectifying section were vacuum-jacketed; heat was provided by a constantan heater in the boiler, the leads for which emerged through the top of the still through a wax seal. The entire still was immersed in liquid hydrogen, thereby maintaining a constant temperature throughout the distillation. The progress of the distillation was followed by means of a manometer which registered the pressure of the vapor in equilibrium with the boiling charge at liquid hydrogen temperature. The points at which fractions should be cut were thereby indicated.

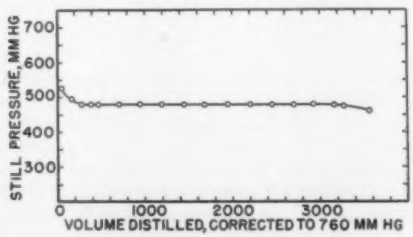

FIG. 2.

This is shown on the accompanying curve (Fig. 2) for the distillation of a charge of about 4,500 ml of crude hydrogen deuteride.

Employing a boil-up rate of 11 ml of liquid per hr and a reflux ratio of the order of 15: 1, there was obtained 10 l of hydrogen deuteride of 99.8% purity in terms of hydrogen isotopes. Because of the difficulties inherent in the mass spectrographic method for measuring trace impurities in hydrogen isotope samples, it is believed that the purity may be even higher. This degree of purity, obtained by means of one distillation of the crude, compares very favorably with that previously obtained from the equilibrium mixture by Scott and Brickwedde in two distillations. This is undoubtedly due to the fact that the starting material used by them was much poorer in hydrogen deuteride than that used in this work.

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The Effect of 2,4-D on Potassium Nitrate Levels in Leaves of Sugar Beets[1]

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As early as 1946 research workers in the U. S. Department of Agriculture showed that 2,4-D in pure form at relatively high levels was not toxic to cattle. They concluded that the amount of 2,4-D that might be consumed by cows or sheep in grazing pastures sprayed with this material to kill weeds would not be injurious (*1*). Extensive grazing trials undertaken at the Michigan Agricultural Experiment Station in 1949 substantiated these earlier observations (*2*), and indicated that cattle grazed 2,4-D-sprayed and unsprayed areas indiscriminately. It has been commonly observed that weeds such as pigweed (*Amaranthus* spp.), ragweed (*Ambrosia* spp.), and even such plants as Jimson weed (*Datura stramonium*), which under normal conditions are not grazed by cattle, are eaten with relish after they have been treated with 2,4-D. A number of cases have been reported of cattle becoming ill, or dying, after eating

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the above species of weeds that had been treated with 2,4-D. Reports of cattle poisoning, or death, following the grazing of 2,4-D-treated weeds, have to our knowledge, in no case been definitely and authentically identified with the direct or indirect action of 2,4-D.

The poisoning of livestock through grazing of oats hay, or straw, and other plants, under unfavorable conditions of development of the plants, has been well established by a number of workers (*3, 4, 5*), who have tentatively set the lower toxic limit of potassium nitrate in forage on a dry weight basis as 1.5%. The potassium nitrate or other nitrates commonly found in plant bodies are not in themselves toxic to ruminants, but the nitrates are changed to nitrites as a result of the action of microorganisms in the rumen. The nitrites cause the formation of methemoglobin in the blood stream, which interferes with the transfer of oxygen from the lungs to the body tissues, and may cause death of animals through anoxia within a few hours. Animals affected with nitrate poisoning show general symptoms associated with oxygen deficiency, such as the distinctive brown color of the blood, which is recognizable by the gray-tan appearance of the mucous membranes of the nose and mouth. This symptom indicates the presence of methemoglobin, which gives the blood the brown-red color instead of the bright-red color normally derived from the oxyhemoglobin. A 2% solution of methylene blue in water is a recognized counteractive treatment for nitrate poisoning.

Several researchers have shown that sublethal dosages of 2,4-D increase protein content of wheat (*6, 7, 8*). Hullinger (*9*), in a preliminary study of the effects of 2,4-D on nitrogen and carbohydrate metabolism of the corn plant, showed marked changes in these constituents in various parts of the corn plant following 2,4-D absorption. The data of these investigators clearly indicate that sublethal dosages of 2,4-D may markedly affect the metabolism of treated plants, and that this upset in the normal metabolism may result in accumulation of toxic quantities of nitrates similar to those established for plants growing under abnormal conditions, such as drought.

Sugar beets are more sensitive to 2,4-D than most field crops. Concentrations of 100 ppm will kill beet seedlings. Beets beyond the four-leaf stage of development are markedly affected by concentrations of 2,4-D at this level (*10*). These abnormal growth characteristics resulting from light applications of 2,4-D were well described by Tanner (*11*) in a recent article. Beets beyond the four-leaf stage of development are killed by concentrations of 2,4-D between 500 and 1,000 ppm, and death at these more advanced stages is slow. Sugar content is reported by Tanner to be markedly lowered, and reductions in yield vary with date of treatment preceding normal harvesting of the beets. In mid-August in 1949, 335 acres of beets belonging to 7 growers in North Dakota were sprayed with a supposedly Toxaphene mixture to control a late brood of webworm. After application it became evident that this insecticide had been contaminated or mixed with a high percentage of 2,4-D. This matter was brought to our attention by J. C. Tanner (*11*), and samples of beet leaves from each of the 7 treated farms, together with 3 samples of leaves from untreated beet fields on adjacent farms, were secured through the courtesy and assistance of E. A. Helgeson and his associates, of the Botany Department, North Dakota Agricultural Experiment Station. These samples were air-dried and analyzed for potassium nitrate by the Chemistry Section of the Agricultural Experiment Station of South Dakota during the winter of 1950.

Table 1 shows that potassium nitrate in dry leaves

TABLE 1

EFFECT OF 2,4-D ON THE POTASSIUM NITRATE CONTENT OF LEAVES OF SUGAR BEETS

Sample no.	Treatment	KNO_3 per cent of dry weight of leaves	
1	None	0.20	
2	"	0.22	
3	"	0.25	
	Average of untreated		0.223
4	2,4-D	1.81	
5	2,4-D	2.26	
6	2,4-D	4.41	
7	2,4-D	4.65	
8	2,4-D	4.68	
9	2,4-D	5.01	
10	2,4-D	8.77	
	Average of treated		4.50

of normal sugar beets averaged 0.22%. This level of potassium nitrate is considered within the normal range for dried beet leaves and is well below the minimum lethal toxic level. The potassium nitrate level in dried leaves of beets from the 7 farms where 2,4-D had been accidentally applied, was at an average level of 4.5%, with a variation of 1.81–8.77 (Table 1). All samples of 2,4-D-treated beet leaves analyzed showed potassium nitrate at a level well above that considered as the minimum lethal concentration. Leaves of beets from the fields on which these samples were taken were not fed to livestock. It is evident that feeding of the material would have been highly hazardous, certain to be followed by considerable losses.

The data of Table 1 indicate clearly that variously reported cases of livestock losses following grazing of 2,4-D-treated weeds and crops may well have been caused by potassium nitrate poisoning, resulting from accumulation of nitrates in sprayed plants as a secondary response of the plants to the action of 2,4-D. It is evident that investigation is necessary in order to establish the varietal reaction of weeds and crop plants to 2,4-D, with special emphasis on accumulation of potassium nitrate where postgrazing of the treated plants occurs. A review of the literature and data of this study indicates further that, where cases of poisoning of livestock following 2,4-D treatment are reported, the distinctive symptoms of nitrate poisoning should be diagnosed, with the remedial action or measures developed by earlier workers employed. Further, grazing or feeding of sugar-beet tops, oats hay and straw, corn sorghum, pigweed, or lambsquarters, and other closely related species of weeds should be undertaken with caution following intentional

or accidental spraying with 2,4-D until the role of 2,4-D in the accumulation of toxic quantities of nitrates in these species has been more fully determined.

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An Analysis of the Enzyme Activity of the Conditioned Salivary Response in Human Subjects

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In the early work on conditioning, it was generally assumed that the conditioned response was identical with the original or unconditioned response, both in a qualitative and a quantitative sense. Later, many workers, including Pavlov, found that the conditioned response did differ in a quantitative way from the original response. As a rule, it was found to be less vigorous (motor responses) or associated with a decreased amount of saliva (glandular response). The aim of the present experiment was to determine whether there is any chemical difference in the saliva of human subjects between the original and the conditioned response.

Eleven female college students were used in the experiment. Four specimens of saliva were taken from each subject: previous to the experiment, during the response to a bell before conditioning, during the presentation of food, and after the process of conditioning had been completed. The saliva was collected from the sublingual spaces by means of a glass pipette, so that the secretion from all the salivary glands would be represented.

The tests were made in an isolated room, with the blinds drawn to eliminate gross nonexperimental stimuli. Each subject was tested individually during a single session of about 3 hr. The unconditioned stimulus was a Cryst-O-Mint candy wafer, which induced a free flow of saliva and was neutral with respect to the chemical techniques later applied. The conditioned stimulus was an electric bell. The subjects were instructed not to eat or smoke for 4 hr previous to the series of tests and reported that they had adhered to this schedule.

The bell preceded the wafer by 10 sec, and the latter was held on the tongue for 20 sec during each trial, following the suggestion by Razran (*1*). The paired stimuli (bell–wafer) were given at short, irregular intervals, so that the time interval itself could not operate as a conditioned stimulus. The time interval between presentations of the pair ranged from 30 to 90 sec, and the series of presentations was randomized. The conditioning phase consisted of 150 paired presentations.

At ½-hr intervals, each subject was asked to report any change in the amount of the salivary secretion noticed. The 11 subjects utilized in this experiment reported a definite increase in saliva from the first interval onward.

The amount of amylase in the saliva was measured for each condition. This substance was chosen because it is the starch-hydrolyzing enzyme and the most active component of saliva (*2*). The results are reported in units of amylase activity per ml of saliva. One unit of amylase may be regarded as the amount required to digest 5 ml of 1% soluble starch to the achromic point in 10 min under the conditions of the standard analysis as presented by Hawk, Oser, and Summerson (*3*). The analytical reagents employed were: (1) light-yellow aqueous iodine solution, (2) 1% aqueous solution of soluble starch, (3) 1% aqueous solution sodium chloride, and (4) phosphate buffer ($K_2HPO_4 + KH_2PO_4$) adjusted to pH 6.6.

The results of this experiment are: (1) With respect to amylase activity, there is a statistically significant quantitative difference between the salivary secretion in response to a conditioned stimulus and the reflex response. (2) There is more amylase activity in the salivary component during the conditioned response phase than in the unconditioned response. There is a mean gain of 31.7 in units of amylase activity in the salivary conditioned response over that of the unconditioned response. This difference is significant at the 0.01 level of confidence. (3) The amylase activity in the determination of experimental conditions (1) and (2) is consistently close.

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Spectrophotometric Assay of Ascorbic Acid with Peri-Naphthindanetrione Hydrate

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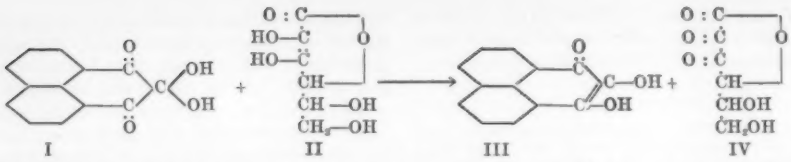
When peri-naphthindanetrione hydrate (I) (*1, 2*) is allowed to react with ascorbic acid (II), the reaction is of a reddish color owing to the formation of dihydroxy-peri-naphthindone (III) (*3*). This reaction is an oxidation reduction system in which the stage of oxidation stops at the point of the formation of dehydroascorbic acid (IV).



I II III IV

The proportionality of the color obtained in this reaction is in good agreement with Beer's law.

We have used this reaction in the estimation of ascorbic acid through spectrographic determination of dihydroxy-peri-naphthindone produced by reduction of the reagent by ascorbic acid in pure solution. The amount of the reduction product thus produced is estimated by the intensity of absorption at 475 mμ; the excess of the reagent, which should always be present, does not absorb at this region of the spectrum. This is not true if estimation is carried out at 345 mμ, and higher values are obtained. However, if just enough reagent is added to react completely with the known amount of ascorbic acid present, good results have been obtained.

The nature of this reaction is illustrated by the following experiment. Eleven milligrams of pure ascorbic acid is weighed, dissolved, and completed to 100 ml with ethyl alcohol. To 5 ml of this solution is added one ml of peri-naphthindanetrione hydrate in alcohol (2 mg/one ml). These are mixed thoroughly and stoppered at room temperature. The color gradually develops and reaches its maximum intensity after 10 min, when it is ready for estimation. The stability of the color permits its measurement with ease at any time from 10 min to 24 hr after the reagents are mixed. A cell of 5-mm thickness is filled with this solution; the control cell is filled with pure ethyl alcohol and is estimated, using a Hilger Barfit quartz spectrograph.

For pure dihydroxy-peri-naphthindone the two bands, one being in the ultraviolet and the other in the visible part of the spectrum, have intensities which can be expressed as $E\frac{1\%}{1\ cm}\ 345 = 525$ and $E\frac{1\%}{1\ cm}\ 475 = 150$.

This reagent, apart from the fact that it is easily prepared, inexpensive, and stable, is specific. To a solution of peri-naphthindanetrione hydrate a solution of the possible interfering substances in plant, animal, and biological media was added under the same experimental conditions used in the case of ascorbic acid, and no color was developed. The following substances were tested: glucose, fructose, alanine, leucine, isoleucine, phenylalanine, lactic acid, aceto-acetic acid, pyruvic acid, urea uric acid, acetone, and dehydroascorbic acid.

Details of this method will be published elsewhere.

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A Method for Evaluating the Relation of Glycogen to Inorganic Salt Deposition in Surviving Cartilage Slices *in Vitro*[1]

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Glycogen has been known to be present in the hypertrophic cartilage cell for almost a century (*1*), and its relation to the ensuing ossification of the cartilage was suggested by Creighton (*2*) as early as 1896. The evidence that has accumulated since then has been, for the most part, favorable to the concept that a close relationship exists between the region of glycogen accumulation in cartilage prior to calcification and the area of subsequent lime salt deposition (*3*, *4*).

Harris (*5*) suggested that the role of glycogen was to furnish phosphate ester substrate, possibly for the phosphatase found to be present in cartilage by Robison (*6*). More specific evidence of the relation of glycogen to calcification was provided by Gutman and his associates, who demonstrated phosphorylase activity in cartilage (*7*), as well as the role of phosphorylative mechanisms in the deposition of calcium in cartilage *in vitro* (*8*). This latter observation has been confirmed in our laboratory and found to apply to strontium as well (*9*). Interest in strontium grew out of experiments in man which suggest that strontium can supplement calcium to cause a more rapid remineralization of the skeleton in osteoporosis than usually occurs with calcium alone (*10*).

Previous histochemical studies dealing with the relation between glycogen and calcification of cartilage have utilized techniques which involved a comparison of the glycogen-staining areas in one piece of cartilage with the calcified portion in another (*4*). It is the purpose of this note to describe a method by which a direct correlation can be made in the same cartilage slice between the glycogen zone and the area of subsequent lime salt deposition. The procedures involved are simpler than those required for the staining of glycogen in fixed sections, and the method is particularly applicable to the analysis, in surviving cartilage slices, of the enzymatic reactions involved in the process of calcification.

The details are as follows: The proximal ends of the tibiae and the distal ends of the femurs of mildly rachitic

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[2] U. S. Public Health Service postdoctorate research fellow.

TABLE 1

EFFECT OF PREINCUBATION OF RACHITIC CARTILAGE IN BASAL SOLUTION ON GLYCOGEN CONTENT AND SUBSEQUENT CALCIUM AND STRONTIUM DEPOSITION *in vitro*

Zone	No. of experiments*	Controls		Experimental	
		Fresh bone slice	After incubation in nutrient media†	After incubation in basal solution	After incubation in basal solution; then incubation in nutrient media
Glycogen-staining area	32	+++	...	0	...
Calcium deposition	16	...	++++	...	0
Strontium deposition	16	...	++	...	0

* Four bone slices per experiment. All incubation periods were for 18 hr at 37.5° C.

† Calcifying or strontifying media.

rats are dissected free of soft tissue, and sliced longitudinally. The freshly dissected bone slices are stained for glycogen by exposing them to the vapors of Lugol's solution for 15 min at a distance of 0.5 cm from the surface of the solution. The bone slices are then examined under 80× magnification, and the extent of the glycogen-staining area is noted. They are then placed in a 0.1 per cent KI solution for 10 min to remove the iodine. Complete removal of the iodine is essential to avoid its interference with the subsequent deposition of inorganic salts. The above procedure accomplishes this, as far as could be detected by the reexamination of the slices under 200× magnification. The bone slices are washed free of KI in 2 changes of a noncalcifying modified Ringer-bicarbonate solution containing NaCl 70 meq, KCl 5 meq, $NaHCO_3$ 22 meq per liter. They are then incubated for 18 hr at 37.5° C in the above medium, to which phosphate and calcium or strontium are added in appropriate concentrations for inorganic salt deposition (*8*, *9*). The incubation is carried out in a Warburg bath, with gentle shaking, in stoppered 25-ml Erlenmeyer flasks containing 10 ml of the incubation medium. Throughout the incubation period the medium is in equilibrium with a mixture of 5% CO_2–95% O_2 in the gas space and thereby is maintained at a constant pH of 7.4. Following incubation, the bone slices are stained by a silver nitrate technique (*8*) to reveal the newly deposited inorganic salts, and placed in glycerol in order to clear the specimen and preserve the silver stain. Under 80× magnification, a direct comparison can be made between the area of inorganic salt deposition and that previously found to contain glycogen.

Iodine does not stain glycogen exclusively (*11*). With the technique described above, the glycogen-containing areas are stained a reddish brown and the remainder of the epiphyseal cartilage takes on a diffuse yellowish hue. The differences in the staining properties are sufficient, however, to permit the ready differentiation and demarcation of the glycogen-containing areas at 80× magnification.

Utilizing this procedure prior to incubation *in vitro*, glycogen was found to be present in the zone of hypertrophic cartilage cells, and to be undetectable in the zone of cells nearest the primary spongiosa, as well as in the resting cartilage cell zone. There was a close correlation between the glycogen-containing area and the region in which both calcium and strontium were deposited after incubation *in vitro*. However, the deposition of inorganic salts tended to extend slightly below the lower border of the area in which glycogen could be visualized by the technique described.

In order to determine more directly than in previous studies the relation between variations in glycogen content and the ability of cartilage to deposit inorganic salts *in vitro*, the following experiments were carried out.

In the first group (Table 1) bone slices were stained for glycogen prior to and following 18 hr of incubation in the basal solution described above, containing no calcium, strontium, or phosphate. This period of incubation resulted in the complete disappearance of the glycogen-staining areas. When such bone slices were then reincubated in a calcifying or strontifying solution for an additional 18 hr, no deposition of strontium or calcium occurred.

In the second group of experiments (Table 2) bone slices were stained for glycogen prior to and following a 45-min exposure to saliva (as a source of amylase), with changes of saliva every 10 min. This procedure led to a marked diminution in the glycogen-staining area. On subsequent incubation of the bone slices in a calcifying or strontifying medium, the extent of deposition

TABLE 2

EFFECT OF SALIVA (AS A SOURCE OF AMYLASE) ON GLYCOGEN CONTENT AND SUBSEQUENT CALCIUM AND STRONTIUM DEPOSITION IN RACHITIC CARTILAGE *in vitro*

Zone	No. of experiments*	Controls		Experimental		
		Fresh bone slice	After incubation in nutrient media†	After incubation in saliva	After incubation in saliva; then incubation in nutrient media.	After incubation in saliva; then incubation in nutrient media + glucose-1-PO_4
Glycogen-staining area	32	+++	...	+	...	...
Calcium deposition	20	...	++++	...	+	+++
Strontium deposition	12	...	++	...	0	+++

* Four bone slices per experiment. All incubation periods were for 18 hr at 37.5° C.

† Calcifying or strontifying media.

of inorganic salts was markedly less than occurred in the control slices. However, if the bone slices, after exposure to saliva, were incubated in a calcifying or a strontifying medium to which glucose-1-phosphate was added, inorganic salt deposition comparable in degree to that in the control slices did occur.

It is evident that the removal of glycogen from cartilage prior to its exposure to a calcifying or strontifying solution markedly interferes with the deposition of these cations. These observations provide additional evidence of the importance of glycogen in the preparatory stages of inorganic salt deposition in cartilage *in vitro*. The influence of the addition of glucose-1-phosphate is consistent with its position in the phosphorylative glycolytic cycle.

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Plant-Growth Inhibitors from Red Kidney Bean Seeds

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In a previous publication (*1*), the writer reported the presence of photolabile germination and growth inhibitors in seeds of the red kidney bean (*Phaseolus vulgaris*). It was maintained at that time that only aqueous preparations were active and that extracts of the whole bean possessed the greatest inhibitory activity. The work reported here includes further investigation of seed coat extracts only. Somewhat different extraction techniques have yielded ether fractions containing inhibitory substances.

As before, the test object employed was the root or root and hypocotyl of the flax seedling. Flax seeds were germinated and grown in Petri dishes on filter paper; this substratum was moistened with aqueous extracts, or with water, after ether preparations had been evaporated to dryness on them. At the end of an incubation period of 45–50 hr, the length of the emerged root or of the root and hypocotyl was measured. Incubation temperature ranged from 24° to 27° C.

TABLE 1

EFFECT OF SEED COAT EXTRACTS ON THE EMERGENCE OF FLAX* (MM)

	Control	Skelly	Ether P	Ether Y	Aqueous
Length of root plus hypocotyl	10.5	10.8	3.9	7.8	6.0
Percentage of control	100	103	37	74	57
Density at 320 mμ	....	....	0.600	0.600	...
Density at 585 mμ	....	....	0.179	0.055	...

* Based on 30–50 seedlings incubated 48 hr with 3 ml of extract; extracts in organic solvents were dried on the filter paper, and the 3 ml of water then added.

Whereas in previous work attempts to extract dry seed coats with ether failed to disclose inhibitors, extraction with ether in the presence of water yielded clear, purple ether fractions with activity. Extracts were obtained as follows: Bean seeds were soaked in water at room temperature for no more than 3–4 hr to soften seed coats; these were then removed. For extract P-3, 10 g of dry seed coats, 30 ml of water, and 30 ml of diethyl ether were placed in 125-ml Erlenmeyer flasks and kept in darkness, with occasional shaking, for about 12 hr. The ether fraction, by this time a deep, clear purple, was separated, shaken 2–4 times with the red-orange aqueous phase, and dried over anhydrous sodium sulfate. Extracts were stored in darkness until use. All operations were conducted in darkness or in diffuse light that did not exceed 15 ft-c intensity. Extract P-4 was prepared using 10 ml of water, 50 ml of ether, and an 8-hr extraction period; continuous agitation was maintained, using a reciprocal shaker. By this method, 100 g of seed coat was extracted, and the ether fractions were concentrated *in vacuo*; the concentrate was dried at 5° C over sulfuric acid.

Other modifications of the techniques described have been successfully employed. Using a Beckmann Model DU spectrophotometer, absorption spectra of the ether extracts were studied for several reasons: (1) once having established the characteristic absorption for the first extract prepared, the presence of the same absorption peaks (Table 1) in subsequent preparations served as a check on the extraction method; (2) it was desirable to find if destruction of the purple pigment in the extract (through the agencies of light, alkali, etc.) was correlated with changes in the inhibitory properties of the preparation.

The relative activities of several preparations are given in Table 1. The greatest activity was found in the purple ether fraction (Ether P); shaking this preparation with sodium hydroxide pellets transformed the extract to a yellow color and diminished its activity by a factor of two (Ether Y).

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Exposure of purple ether fractions to white or yellow light of 1,000 ft-c intensity for periods of 0–30 min resulted in a decrease in absorption at 585 mμ from 0.179 at 0 min irradiation to 0.075 at 30 min; there was no significant decrease in inhibitory activity. Irradiation for 45–50 min, on the other hand, reduced the absorption to 0.015 and the inhibitory activity from 45% of control to 60–63% of control.

The concentrate of extract P-4 yielded 40 mg of a red-brown solid from 100 g of seed coat. This solid was no longer soluble in ether to any extent and failed to give any purple coloration. Further, the inhibiting activity was one half as great as that of freshly prepared ether solutions. This concentrate was completely inactivated by 60 min exposure to 200–400 ft-c of white light, when in aqueous solution.

In another set of experiments, ether fractions were applied to carefully weighed disks of 9-cm filter paper. These were weighed again after the ether had been evaporated. Quantities of this concentrate ranging from 16 to 100 mg of dry material were deposited on the filter papers (the error in this method is 5–10%). Applying 2–4 ml of water to these disks in Petri dishes, concentrations of 4–50 mg/ml were obtained. Flax seeds were then germinated on the filter paper, and measurements of root length taken after 45 hr incubation. With concentrations below 20 mg/ml, irregular results were obtained, but using concentrations from 20 to 50 mg/ml, regular results were obtained. At 0 mg/ml, root growth in the stated interval was 4.4 mm; with 20 mg/ml, 4.2 mm; with 30 mg/ml, 3.3 mm; with 50 mg/ml, about one third of control growth was obtained. Irradiating the extract having a concentration of 30 mg/ml with 500 ft-c of white light for 15 min completely inactivated the inhibitor. Figures are based on 30–35 roots per group.

These inhibiting solutions were also observed to suppress root hair development considerably.

There is some indication that the ether-soluble system is thermolabile. Previously, the aqueous seed coat extract was found to be inactivated by heat (*1*).

Although Barton and Solt (*2*) reported inhibitory activity in the seed coats of pole bean varieties (*Phaseolus* sp.), they found greater activity in aqueous extracts than in those made with organic solvents, as did the present author previously. It is evident from Table 1 that the ether extracts have higher activity than aqueous preparations; whether this is a result of differences in concentration or in the nature of the inhibitor is not known.

The evidence presented here indicates that a relationship may exist between the purple coloration of the ether fractions and at least some of the inhibitory activity of these extracts. Both light and alkali diminished biological activity and destroyed the pigment. This indicates either the presence of two or more inhibitors or of a single labile inhibitor molecule. Among the effects of cold alkali on organic molecules is its ability to open lactone rings; further, some lactones are known to exert effects on plant growth (*3*, *4*). Finally, it is of interest to note that like auxins *a* and *b*, the ether fraction of the bean seed coat is sensitive to alkali (*3*, *4*). These latter observations are of a speculative nature, but may give some clue as to the kind of substance or substances acting as inhibitors.

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Adjuvant Action of Amino Acids and Peptides in Fertilizin Agglutination of Starfish Sperm[1]

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Starfish (*Patiria miniata*) sperm in 1–2% sea-water suspension are generally immobile and do not agglutinate appreciably upon addition of the specific isoagglutinin fertilizin. However, when treated with an appropriate adjuvant (hen's egg white or various vertebrate or invertebrate sera) the sperms become intensely active, agglutinate strikingly and specifically upon addition of homologous fertilizin, and show a marked increase in fertilizing power (*1*).

In an attempt to discover the chemical nature of the adjuvant, a series of amino acids and related substances was tested for adjuvant action on the Pacific webbed star, *P. miniata*. Most of the α-amino acids and peptides proved to be very effective adjuvants. All substances tested were prepared as 0.1*M* solutions (saturated solutions in the case of less soluble compounds) and the pH of each solution was adjusted to that of sea water (pH 7.9) with 1N HCl or NaOH. In most of the tests 1 vol of 1–2% *P. miniata* sperm and 2 vol of test solution were mixed, and finally 1 vol of fertilizin was added. Controls for the action of sea water, test solution, and fertilizin alone were run in all cases. An experiment was rejected if agglutination occurred in any of these controls.

The adjuvant action of amino acids and peptides appears to be identical with that of hen's egg white and sera, previously described (*1*). Thus the agglutination resulting from addition of fertilizin to amino acid- or peptide-treated *Patiria* sperm is exclusively head to head and does not reverse within a limited time. Furthermore, the reactions are species-specific. Specific agglutination reactions but no cross-reactions were observed with amino

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TABLE 1

ADJUVANT ACTION OF AMINO ACIDS AND RELATED SUBSTANCES IN FERTILIZIN AGGLUTINATION OF *Patiria miniata* SPERM

	Substance tested	Adjuvant action or adjuvant titer*	
l	Cystein	4,096	
	Glutathione	512–1,024	
l	Proline	64	(all reactions very weak)
dl	Leucine†	64	
dl	Alanine	32	
dl	Valine	32	
	Glycine	16	
l	Lysine	4–8	
d	Lysine	4	
	Glycylglycine	2	
	Glycine methyl ester	2	
dl	Glutamic acid†	2	
dl	Phenylalanine†	+	
l	Aspartic acid†	+	
l	Tryptophane	+	
	α-amino butyric acid	+	
	β-amino butyric acid	–	
	β-alanine	–	
	N-methyl glycine	+	(all reactions very weak)
	N-dimethyl glycine	–	
	Hippuric acid†	–	
dl	Acetyl valine	–	
	Acetate	–	
	Pyruvate	–	
	Acetamide	–	
	Ethyl amine	–	
	Ammonium chloride	±	

* Reciprocal of highest dilution of 0.1*M* solution showing adjuvant action. All titrations were not run simultaneously. Titers are related to glycine taken as 16.

† Saturated solution.

acid-treated sperm and fertilizin of *P. miniata*, *Astrometris sertulifera*, and *Pisaster ochraceus*.

Examination of Table 1 shows that every one of the α-amino acids tested showed adjuvant action. This clearly indicates that at least within wide limits the α-amino acid structure is effective regardless of the attached radical. However, the activity of the various amino acids and peptides is not independent of the attached residue, as can be seen by comparing the adjuvant titers shown in the table. Both the D and L forms of the amino acids seem to be effective, since both isomers of lysine were active. The α structure is not only effective but would seem to be required, since the β-amino analogues of alanine and amino butyric acid produced no adjuvant effect.

Apparently esterification or peptidization of the carboxyl group, as in glycine methyl ester or glycylglycine, respectively, reduces but does not destroy the activity of an amino acid. However, a free α-amino group would appear to be essential for satisfactory adjuvant activity. Thus the α-imino acids proline, sarcosine (N-methyl glycine), acetyl valine, and hippuric acid showed little or no activity and the tertiary amino derivative N-dimethyl glycine was completely inactive. In view of these considerations, it would appear that a free amino group and a carboxyl (free or esterified, but preferably free) group on adjacent carbon atoms is one essential structure for adjuvant action.

A carbonyl group in place of a carboxyl group, as in the peptides, may be sufficient for adjuvant action. However, it is possible that peptidases hydrolyze the peptides to amino acids and that the latter are responsible for the adjuvant action of peptides. Assuming that a carbonyl group can substitute for a carboxyl group, the essential structure outlined above can account for the adjuvant action of crystalline ovalbumen (1% sol) and crystalline bovine serum albumen preparations observed in this study. Assuming that peptide linkages are broken or that masked terminal α-amino groups of proteins are exposed by boiling or by ultraviolet irradiation, the increase in adjuvant action of egg white and the presence of a heat-stable, nondialyzable (polypeptide†) adjuvant(s) in egg white and sera (*1*) are explained. The heat-stable egg white proteins lysozyme and ovomucoid (trypsin inhibitor) are inactive. Finally, the assumption that an increase in α-amino groups occurs through bacterial hydrolysis of protein explains why aged *Patiria* fertilizin solutions stimulate and agglutinate homologous sperm in the absence of added adjuvant (*2*).

The mechanism of adjuvant action of the amino acids has not been investigated, but presumably the amino acids operate in the same manner as the poorly defined adjuvant of hen's egg white. The available evidence (*1*) indicates that the latter acts upon the sperm to expose more antifertilizin groups on the sperm surface, thereby converting the normally "univalent" sperm to a multivalent agglutinable form. How the amino acids could achieve such a conversion is not clear. The effective chemical structure outlined above, and the fact that the active agents stimulate the sperm to intense activity, suggest that sperm metabolism is involved in the adjuvant effect. However, the immediate products of amino acid oxidase action are not effective adjuvants. Thus pyruvic acid, the α-keto analogue of alanine, proved to be completely inactive, and ammonia showed only a very slight adjuvant effect at one concentration in one experiment. Since alkali has a very striking adjuvant effect on starfish sperm (*2*), it is tempting to ascribe the adjuvant effect of amino acids to an increase in pH as the result of the release of ammonia. However, addition of alanine produced no detectable pH change in an *Asterias forbesii* sperm suspension. Furthermore, a decrease rather than an increase in pH should be the immediate result of amino acid oxidase action on alanine, since pyruvic acid is more dissociable than ammonium hydroxide (*3*). Nevertheless, if the keto acid were metabolized to a less dissociable acid (such as CO_2 via the citric acid cycle), leaving the ammonia to accumulate, a local if not an over-all rise in pH could result even in a highly buffered solution. Whether this is the actual mechanism of action of the amino acids can only be decided by further study.

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A Simple Method for the Determination of Diffusion Constants

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Measurement of the diffusion constant of a substance in solution depends upon the determination of the concentration of the solute as a function of time and distance from an initially sharp boundary between solution and solvent. Knowing the concentration of the solute, one may calculate the diffusion constant by means of the equations

$$C_x = \frac{C_o}{2}\left(1 - \frac{2}{\sqrt{\pi}}\int_o^y e^{-y^2}\,dy\right) \quad \text{and} \quad y^2 = \frac{x^2}{4Dt}.$$

These equations hold for free diffusion of the solute from one half of the tube, with initial concentration C_o, into the other half, with initial concentration $C_x = 0$, where C_x is the concentration at any distance x from the original boundary, and y is a parameter related to the time t, the diffusion constant D, and the distance x, from the initial boundary by the second equation above. The method for the derivation of the above equations from Fick's first and second equations is given by Williams and Cady (*1*), and by Neurath (*2*). The boundary conditions are the concentrations as stated above, and the condition that no change in concentration shall occur at the ends of the tube during the measurements. The term $\frac{2}{\sqrt{\pi}}\int_o^y e^{-y^2}\,dy$ is the probability integral. Measuring C_x and C_o, one knows the value of the integral, hence the upper limit of the integral (*3*). Then, using the second equation above, knowing y, x, and t, one can calculate D.

The present method depends upon the fact that if the substance the diffusion constant of which is to be determined can be prepared in radioactive form, the cpm that one observes in a thin cross-sectional slice of a column containing the substance is directly proportional to the concentration of the substance in the slice. Thus, if one can count activity in many such slices as a function of time and distance from an initial boundary between solution and solvent, one can calculate a diffusion constant for the diffusion of the substance into the solution. The method can also be applied to self-diffusion problems.

Fig. 1 shows the apparatus, which consists of a hollow brass tube, with walls about 6 mm thick to shield out β-radiation, and in internal cylindrical bore of about 14 mm diameter, just large enough to accommodate a lusteroid tube of about 13.5 mm outside diameter, and 87 mm long. Inside the brass tube, which is about 15 cm long, is a snugly-fitting brass disk which acts as a platform on which the lusteroid tube can ride up and down. The platform is moved up and down by means of a 1/32-in. pitch screw having 88 turns. When the disk is completely screwed in, the bottom of the lusteroid tube comes just opposite a slit in one side of the brass tube, 1/32 in. wide. The length of the screw is such that, with 8 ml of liquid in the lusteroid tube, any cross section of the liquid level can be brought in line with the slit. The length of the slit is increased by 44 mm by means of the adjustable brass blocks, as shown. These blocks increase the resolving power of the slit by reducing the geometrical error, for as the length of the slit is reduced, one observes through the slit not, as one should, a thin cross-sectional slice, but rather a solid angle subtended by the eye at the slit. An end-window Geiger tube is placed flat against the brass blocks opposite the slit, and all measurements during a given diffusion experiment are made in this fixed position. In order to form the boundary, exactly 4 ml of the radioactive material was introduced into the bottom half of the lusteroid tube. A tiny flat saucer made from 230-mesh stainless steel wire was carefully pushed into the tube by means of a cylindrical wooden peg just smaller than the inside diameter of the tube. The saucer was pushed flat onto the surface of the liquid, and small bubbles were removed by careful pressure with a fine glass stirring rod. The second layer was then slowly added, exactly 4 ml being used. The screen should allow free diffusion, yet prevent mechanical mixing.

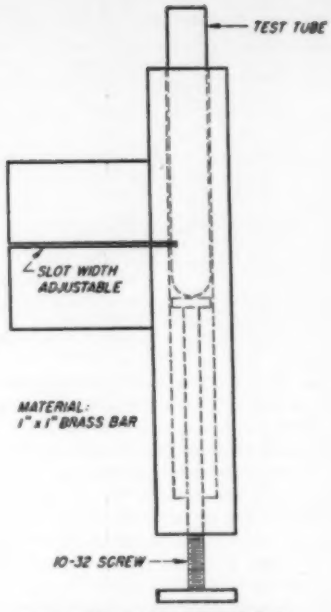

FIG. 1. Apparatus for diffusion experiments.

This method for determining diffusion constants is limited by several factors. Its principal disadvantages are the following: First, the slit must be of appreciable width in order to get enough counts through to the counter. In using a slit of finite width one is not measuring concentration in an infinitely thin slice.

[1] Present address: University of Kansas Medical Center, Kansas City.

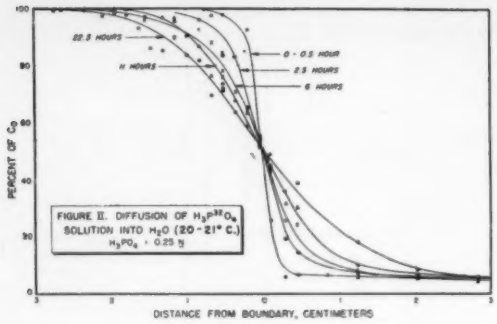

FIG. 2.

Second, even with the lengthened slit there is a slight solid angle in the solution subtended by the counter at the slit. Third, there is always a slight cloud of betas, caused by scattering from regions adjacent to the slice viewed by the slit. Fourth, measurements are limited to compounds tagged with isotopes that are pure β-emitters; γ rays will not be filtered out by the brass. It was hoped that scattering and absorption by the screen would not interfere and that values obtained on each side of the screen could be extrapolated together to form a smooth curve. Finally, since appreciable time intervals are involved in any series of counts along the tube, the resulting curve is not truly isochronal. This error becomes much less appreciable several hours after the beginning of the experiment.

All calculations were made from the curves for the bottom half of the tube since the boundary on that side does not contain the side of the screen.

One must make some distinction between the validity of values of D obtained from the extreme ends of the curve, either very near or very far from the boundary, for the following reasons:

$$\text{Since } D = \frac{x^2}{4ty^2}, \qquad \text{then } \frac{dD}{D} = 2\frac{dx}{x},$$

and it is apparent that the fractional error in D will always be twice that in x. The fractional error in x will decrease as x increases, provided the absolute error in x is constant. Arbitrarily, only values of x greater than 0.2 cm have been used in all the following calculations.

Also, calling the probability integral ϕ, we have:

$$1 - 2\left(\frac{C_x}{C_0}\right) = \phi$$

Differentiating and dividing by C_x we obtain:

$$\frac{dC_x}{C_x} = -\frac{d\phi}{1-\phi}$$

Since, as C_x approaches zero, ϕ approaches 1.0, then the fractional error in C_x—namely, $\left(\frac{dC_x}{C_x}\right)$—approaches infinity. This means that one should not make measurements toward the tails of the curves. Arbitrarily, only values of $\left(\frac{C_x}{C_0}\right)$ greater than 0.05 have been used—that is, regions where the concentration is at least 5% of that in the deep regions (far from the boundary) on the active side of the tube.

All measurements were made in a constant temperature room at 20–21° C. Since the variation of the diffusion constant is given by $\frac{D_1}{D_2} = \frac{T_1}{T_2}$, where T_1 and T_2 are the absolute temperatures (*5*), it was felt that small changes in temperature would not cause appreciable error. The chief error would be caused by mechanical mixing, which was kept to a minimum by careful handling of the apparatus.

Fig. 2 shows 5 isochronal diffusion curves for 0.25 *N* phosphoric acid, for diffusion into water. Table 1 shows

TABLE 1

DIFFUSION OF 0.25 N $H_3P^{32}O_4$ SOLUTION INTO WATER, 20–21° C

Time elapsed after start of experiment, hr	Distance from boundary, cm	D, calculated, cm²/sec
0.5	0.40	0.43×10^{-5}
2.5	.40	0.54
	.59	0.85
	.79	1.52
6.0	.40	0.72
	.59	0.86
	.79	1.05
	0.99	1.25
	1.19	1.42
	1.38	1.57
	1.58	1.70
11.0	0.40	0.80
	0.59	.61
	0.79	.68
	0.99	.65
	1.19	.62
22.5	0.40	.54
	0.59	.51
	0.79	.57
	0.99	.64
	1.19	.72
	1.38	.73
	1.58	0.74
	Average	0.86×10^{-5}

the values for D for phosphoric acid from the 5 different isochronal curves, calculated for arbitrary points within the limits stated above. The average for all these values is $D = 0.86 \times 10^{-5}$ cm²/sec. The value from the *International Critical Tables* for the same solution at 22° C is 0.89×10^{-5} cm²/sec (*4*). This agreement would indicate a reasonable accuracy in the method. The technique was developed to study the self-diffusion of an yttrium-hydroxy-citrate colloid that was too unstable to diffuse against water.

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On the Question of Hyaluronidase in Sea-Urchin Spermatozoa[1]

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It has recently been reported (*1*, *2*) that a hyaluronidaselike agent can be extracted from sea-urchin sperm and that this is capable of dissolving the jelly coat of the eggs. The possibility does not appear to have been eliminated, however, that apparent dissolution of the egg jelly may have been a consequence of precipitation of the jelly (fertilizin) by antifertilizin in the extracts (*3*) or even merely a consequence of gradual dissolution of the jelly resulting from exposure to sea water.

Evidence for the hyaluronidaselike nature of the factor in sea-urchin sperm extracts appears to be based largely upon the fact that it is reportedly obtained by methods commonly employed for extraction of hyaluronidase from mammalian testes. It has also been reported (*1*) that sea-urchin sperm preparations are capable of reducing to some extent the viscosity of a solution of hyaluronic acid.

At the present time two points appear to require clarification: (1) Is an egg-jelly-dissolving factor extractable from sea-urchin sperm by methods used for hyaluronidase extraction? (2) Does hyaluronidase prepared from bull testis or other sources dissolve or otherwise act upon the material of the gelatinous coat of sea-urchin eggs?

In order to obtain evidence that might bear upon these questions, the author prepared extracts of the sperm of two species of Pacific Coast sea urchins (*Strongylocentrotus purpuratus* and *Lytechinus pictus*) by a number of methods which have been described for extraction of hyaluronidase from mammalian testes. For testing, eggs of the homologous species were treated in the different extracts, in solutions containing purified bull testis hyaluronidase (supplied by the Schering Corporation), and in sea water.

In several tests, jellyless eggs were occasionally found in experimental dishes, but an equal, or in some cases a greater percentage, of jellyless eggs was consistently found in control dishes containing sea water. It was observed that different lots of eggs exhibited considerable variation with respect to the presence of the jelly hull after standing in sea water. This probably depends upon the condition of the jelly in a given lot of eggs, i.e., whether it is initially soft or firm, thick or thin. No significance, therefore, could be attached to those cases in which jellyless eggs were found in treated suspensions.

It is of interest that a weak precipitation membrane was observed about some of the eggs in dishes containing sperm extract prepared by a procedure in which the spermatozoa were frozen and thawed—a treatment known to release antifertilizin from sea-urchin spermatozoa. Antifertilizin was present, therefore, in this preparation, but in low concentration, since in no case did the precipitation membrane become heavy or contract to the egg surface. Precipitation membrane formation was not observed in suspensions of eggs treated with bull testis hyaluronidase.

In other experiments advantage was taken of the fact that fertilizin co-precipitates with added protein in acid solution (*4*). Following a procedure patterned after methods described for turbidimetric assay of hyaluronidase with hyaluronic acid, the effect of sea-urchin sperm extracts, as well as of purified bull testis hyaluronidase fertilizin, was tested by a turbidity reduction method.

Incubation of the various sperm extracts with solutions of purified fertilizin at 37° or at room temperature for periods ranging from 30 min to 2 hr proved to be ineffective in reducing the turbidity upon subsequent acidification and addition of protein. In most cases, as a matter of fact, the turbidity was enhanced. Similar results were obtained when hyaluronic acid (Schering) was incubated with these extracts. On the other hand, incubation of fertilizin with purified bull testis hyaluronidase did not cause enhancement of the turbidity, but neither was there any reduction in turbidity even with relatively high concentrations of the enzyme. Incubation of hyaluronic acid with the same hyaluronidase preparation in low concentration resulted in marked reduction in turbidity.

Considerable data are now available concerning the chemical composition of fertilizin, and these show that it is different in this respect from hyaluronic acid (*3*, *5*). Fertilizin does resemble hyaluronic acid insofar as it co-precipitates with added protein in acid solution, but this indicates only a general resemblance shared with acidic mucopolysaccharides such as chondroitin sulfate.

The evidence reported here shows that treatment of spermatozoa of two species of sea urchin by methods employed for the extraction of hyaluronidase from mammalian testes fails to yield an egg-jelly-dissolving factor. Failure of bull testis hyaluronidase either to dissolve the egg jelly or to reduce the turbidity in a turbidimetric system employing purified fertilizin indicates that this substance does not serve as a substrate for mammalian hyaluronidase. This last point is further strengthened by the difference in chemical composition between hyaluronic acid and fertilizin. In general, the results of numerous experiments with the preparations mentioned here, as well as with other sea-urchin sperm extracts, clearly emphasize the importance of controlling the tests adequately with respect to the action of antifertilizin and gradual dissolution of egg jelly in sea water.

[1] Experiments reported here were performed in the laboratory of Albert Tyler, Kerckhoff Laboratories of Biology, California Institute of Technology, Pasadena.

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Comments and Communications

Research Note on Randomization in a Social Experiment

When the sociologist attempts to apply an experimental design to measure the effects of some social program of treatment, such as a public housing program in the free community situation, two obstacles to generalization of results are encountered: (1) the selection of slum families for an experimental group to receive treatment and a control group denied this treatment (admission to the public housing project) cannot ordinarily be randomized, because administrative rules always require that families to be admitted to the project must be the *most needy*; and (2) during the experimental period of 1–5 years, there are losses of cases due to death, mobility, etc., which would destroy any randomization at the outset. In one study of this problem these losses of cases due to death, illness, mobility, refusals, etc., amounted to 12% of the experimental group of slum families admitted to the housing project, and to 42.7% of the families in a matched control group remaining in the slum for the 1-year run of the study. The following design of experimental study would obviate both these difficulties.

The operations would be: (1) take a housing project of limited accommodations, say, 500 dwelling units; (2) build up a pool of 1,000–1,500 eligible and processed families who could be admitted; (3) explain to applicants for admission to the housing project that the limited accommodations require that applicant families draw lots for admission (randomization); (4) then the families that drew lucky numbers will be admitted; and (5) the families that drew unlucky numbers will have to wait their turn as further construction opens up new projects. These rejected families become the control group remaining in slum conditions. In this manner favoritism and bias in admission would be avoided and yet randomization would be obtained. Both groups would be measured for adjustment at the beginning of the experiment, followed through an experimental period of 1–5 years, and then measured for adjustment at the terminal date.

The second dilemma is loss of cases from death, illness, mobility, refusals, etc., during the run of the experiment, thus destroying the initial randomization. The resolution of this dilemma is to randomize the experimental group of residents, and likewise the control group, into 50 small samples of 10 families each. Some of these samples will lose cases during the run of the experiment, but in all probability some of the small samples will not lose cases and hence will remain randomized groups throughout the period. These residual small groups of families may then be the subjects for analysis of variance and covariance to test the results of the experiment. Since experience shows that losses from death, illness, mobility, and refusals are more frequent in the control group than in the experimental group, the control group should be larger than the group of resident families, to allow for shrinkage. Harold Hotelling, in correspondence with the author, points out that it is essential, when randomization into subgroups is carried out, that a careful scheme of analysis of variance should be laid down in advance and in full detail.

The foregoing design should provide a basis for generalization so often lacking in control group studies in the free and uncontrolled community situation. It has the merits of avoiding matching to obtain homogeneity (which experience shows may occasion losses of 27% of the initial cases), and also of avoiding the usual penalty on randomization caused by losses of cases from natural reasons during the run of an experiment.

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Social Responsibility in Science

When Albert Einstein joined the Society for Social Responsibility in Science during the past summer, he made a public statement for the society to use as it pleased. The SSRS feels that Dr. Einstein's statement deserves the thoughtful attention of as wide as possible a group of his colleagues. His statement follows.

William F. Hewitt, Jr.

School of Medicine
Howard University
Washington, D. C.

Dear Fellow-Scientists:

The problem of how man should act, if his government prescribes actions or society expects an attitude which his own conscience considers wrong, is indeed an old one. It is easy to say that the individual cannot be held responsible for acts carried out under irresistible compulsion, because the individual is fully dependent upon the society in which he is living and therefore must accept its rules. But the very formulation of this idea makes it obvious to what extent such a concept contradicts our sense of justice.

External compulsion can, to a certain extent, reduce but never cancel the responsibility of the individual. In the Nuremberg trials this idea was considered to be self-evident. Whatever is morally important in our institutions, laws, and mores can be traced back to interpretation of the sense of justice of countless individuals. Institutions are in a moral sense impotent unless they are supported by the sense of responsibility of living individuals. An effort to arouse and strengthen this sense of responsibility of the individual is an important service to mankind.

In our times scientists and engineers carry particular

moral responsibility, because the development of military means of mass destruction is within their sphere of activity. I feel, therefore, that the formation of the Society for Social Responsibility in Science satisfies a true need. This society, through discussion of the inherent problems, will make it easier for the individual to clarify his mind and arrive at a clear position as to his own stand; moreover, mutual help is essential for those who face difficulties because they follow their conscience.

Very truly yours,

ALBERT EINSTEIN

Concerning the Zoological Record

The Zoological Record was founded in 1864 by a group of British zoologists mainly connected with the British Museum (Natural History) and the Zoological Society of London, with the object of providing each year a comprehensive bibliography of zoological literature. The first volume, dealing with the literature published in 1864, appeared in 1865, and since then the annual series has continued unbroken, a unique example of scientific bibliography. Because of the war there is now, unfortunately, a delay of about two years, and Volume 84, dealing mainly with the literature of 1947, is the last complete volume published, although several separate sections of Volume 85 have already appeared. However, as soon as printing conditions are easier, it is hoped to get back to the normal practice of completing and issuing the *Record* in the year following the literature to which it refers.

It will be obvious that a publication of this nature is most costly to produce and could hardly hope to be self-supporting unless sold at a very high price, but it has always been the policy of the Committee to provide the *Record* at a price within reach of individual research workers. As a result, many difficulties have had to be overcome during its varied history, and it has been dependent to a large extent upon private donations.

The *Record* was first issued by Van Voorst, a London publisher interested in natural history, but after five volumes he abandoned the venture as unprofitable. Volumes 6–22 were issued by the Zoological Association, a private body helped by grants from the British Association for the Advancement of Science, the Royal Society, and the Zoological Society of London. The Association found itself unable to continue after 1886, when the Zoological Society first undertook full responsibility. In 1900 another change in the administration took place with the foundation of the *International Catalogue of Scientific Literature*, published under the auspices of the Royal Society, for one of the annual volumes in this catalogue professed to cover the same ground as the *Zoological Record*. It was agreed, however, after some difficult negotiations, that the Record Committee of the Zoological Society should remain responsible for the compilation and editing of the volume dealing with zoology, with the *International Catalogue* bearing the cost of printing and publishing. This system continued until the first world war, and, with the resulting breakdown of international arrangements, the Royal Society ceased to be responsible for any volumes of the *Catalogue* subsequent to those dealing with the literature of 1914.

The Zoological Society of London then continued to issue the *Record* from 1915 to 1920, reserving a set in sheets for the possible future use of the *International Catalogue*. However, it was not found possible to resume the production of this somewhat ambitious *Catalogue*, and since that date the Zoological Society has undertaken the sole responsibility for the *Record*. It was considered only reasonable, however, in view of its great value to zoologists, that other organizations and individuals should be invited to contribute at least a share of the cost. As a result, a certain number of donations have been received, but they are still inadequate to meet the expenses. In view of the international character of the *Zoological Record*, the committee responsible for its general direction has now been enlarged to include representatives of the British Commonwealth and certain foreign countries. The present American representative is Remington Kellogg, of the U. S. National Museum.

There is a mistaken impression that the *Zoological Record* is of interest only to the systematist, but, as mentioned previously, it is invaluable to workers in all branches of zoology. To provide easy reference the *Record* is divided into sections representative of the various zoological groups, and each reference is allotted to its appropriate section and then dealt with under three headings: (1) Titles, arranged in alphabetical order of the authors' names, with a full bibliographical reference; (2) Subject Index, giving a detailed analysis of the subjects dealt with in each article; and (3) Systematic Index, comprising a list of all the animals referred to in the section concerned, including those described as new forms, arranged in systematic order. This arrangement enables the reader to find the information regarding the current zoological literature of any group under the authors' names, under specific subjects, or under the scientific names of animals.

The nature of the service given by the *Zoological Record* is illustrated in the following excerpt:

I. TITLES.
66.—CHRISTENSEN, J. F. The oocysts of coccidia from domestic cattle in Alabama (U.S.A.), with descriptions of two new species. *J. Parasit.* Urbana, **27**, 1941, pp. 203–220. 2 pls. 1 text-fig.

II. SUBJECT INDEX.
STRUCTURE.
SPOROZOA
Eimeria spp. (including new) from American cattle, CHRISTENSEN, **66**.
ECOLOGY
PARASITISM: Hosts—
MAMMALIA: *Bos taurus*, intestine (U.S.A.): *Eimeria alabamensis* spp.n., *E. subspherica* spp.n. (Sporoz. Coccid.) CHRISTENSEN, **66**.
ECONOMICS
COCCIDIOSIS: Coccidiosis in U.S.A. cattle. CHRISTENSEN, **66**.

III. SYSTEMATIC INDEX.
4. SPOROZOA. (b) COCCIDIIDA
Eimeria alabamensis, *E. subspherica* spp.n. (with key to other spp.) from cattle, U.S.A. CHRISTENSEN, **66**.

As an illustration of the comprehensiveness of the

Record, it may be mentioned that Volume 84, covering the literature for the year 1947, contains references to 12,431 papers and books appertaining to zoology.

The *Record* can be obtained from the Zoological Society of London, Regent's Park, N. W. 8, either as a complete bound volume or in sections. The published price of the complete volume is 80*s*, and the advance subscription price, 65*s*.

S. A. NEAVE, *Secretary*

Zoological Society of London

Book Reviews

German Aviation Medicine, World War II, 2 vols. Prepared under the auspices of the Surgeon General, U. S. Air Force. Washington, D. C.: Government Printing Office, 1950. 1,302 pp. $8.50 the set.

At the close of the second world war in Europe, groups of experts were sent from the United States to Germany to appraise the work in aviation medicine done there during the war. They found that many of the very valuable results were in danger of being lost as a result of the destruction of research institutions and scattering of personnel. Consequently, a plan was formulated and executed under the direction of Major General Malcolm C. Grow, USAF, to establish an Aero Medical Center at Heidelberg, where a group of leading German aeromedical research workers were brought together and provided with the necessary assistance and facilities to collect all available aeromedical research reports, reproduce lost material so far as possible, and organize the whole into a coherent record of German wartime achievement in aviation medicine. This work was carried on with great success, under the direction of Colonel Robert J. Benford, up to March 1947, when it was transferred to the United States, primarily at the School of Aviation Medicine, Randolph Field, Texas.

The present two volumes are the result of this plan. Specifically they are the work of 56 specialists who undertook the writing of the various sections. The contents are divided into 14 major parts, the first two being general and introductory, the rest being devoted individually to specific subjects.

Part I (Hubertus Strughold) gives a brief historical sketch of German aviation medicine, a statistical presentation of the various subjects of research, and a summary of the major fields, showing when, why, and how they were developed.

Part II (H. Beauvais, H. Mauch, H. Kensche, U. K. Henschke) traces the development of German military aircraft in terms of general performance characteristics and tactical use and the parallel progress of aviation medicine. Its final chapter discusses the mechanical-physiological-psychological problems of control.

Parts III, IV, and V are devoted to high-altitude research. The first of these presents physical characteristics (pressure, temperature, air motion, etc.), of the air at various altitudes, (E. Regener), and discusses low-pressure chambers and other equipment, instruments, and techniques used in high-altitude research (H. W. Denzer, H. Rein).

Part IV, written by an imposing array of specialists (E. Opitz, K. Kramer, F. Palme, H. Schaefer, E. Schütz, W. Noell, U. C. Luft, H. W. Denzer, W. Hornberger, T. Benzinger, F. Büchner), occupies roughly half of the first volume. It covers the field of high-altitude physiology (primarily anoxia in humans), with chapters devoted to studies on blood, respiration, heart, and brain. Additional chapters deal with general altitude tolerance, acclimatization, decompression sickness (bends, etc.), explosive decompression, and with animal experiments at reduced pressures and the pathology of anoxia in animals and man.

Part V (T. Benzinger, H. Seeler, W. Hornberger, W. Noell, H. Becker-Freyseng, J. Pichotka) is devoted to a discussion of oxygen equipment, conventional and pressure breathing masks, pressure suits and pressure cabins, and to the physiological problems arising in connection with the design and use of this equipment.

Part VI (H. Freise, O.. Gauer, S. Ruff, F. N. Scheubel, J. Schneider, H. Spatz, H. Haber) deals with acceleration. The several chapters discuss measuring devices, moderate accelerations of several seconds' duration in which the primary physiological effects are cardiovascular, brief, severe accelerations which produce laceration of body tissues, parachute-opening shock, injuries in training gliders, brain injuries, protective equipment (helmets, body armor), and the probable effects of a gravity-free state (in interstellar space) on man.

Volume II leads off with Part VII—"Mechanical Vibration and Noise," (W. Ernsthausen, W. von Wittern, W. E. Loeckle, F. A. Kipp). The topics discussed include sources of sound and vibration in aircraft and the physics and physiology of man's reaction to them, measuring instruments and techniques, physiological effects of mechanical vibrations and noise in aircraft, its physical characteristics and auditory effects.

The very important problems of hot and cold environments are the subject of Part VIII (K. Büttner, H. Kuhn, K. Wesler, F. Grosse-Brockhoff, H. Schwiegk, H. Siegmund). The first two chapters discuss the climatology of the German theaters of operation and the thermal conditions within aircraft cabins. The succeeding three chapters present the general problems of heat balance in man, the physical factors of convection, radiation, evaporation, etc., the physiology of hyperthermia, and the physiology and therapy of hypothermia. These are followed by two chapters on local cold injury, pathogenesis and treatment, pathology, and histology. The final chapter discusses protective clothing.

The great importance of the eyes in aviation and the number and complexity of visual problems is presented in Part IX (H. W. Rose, I. Schmidt, H. J. Autrum, H. Strughold), which contains eight chapters devoted respectively to visual acuity, flying goggles, visual fields, color vision, depth perception, night vision, electroretinograms, and the physiological effects and possible military applications of intermittent light.

Part X (H. Frenzel, H. Strughold) discusses the special problems of the ear and the peripheral mechanoreceptors in aviation. The subjects presented include trauma in the middle ear and the sinuses due to pressure differentials, the equilibrative function of the vestibular apparatus, hearing loss, and the role of the larynx in speech with reference to the use of throat microphones. These are followed by a brief discussion of the pressure sense and posture sense, their importance, and factors affecting their efficiency.

Selection, training, and medical care of flying personnel are the subject of Part XI (A. G. A. Bingel, S. Gerathewohl, K. Kreipe, I. von Hattingberg, H. Becker-Freyseng, O. Graf, G. Lehman, H. Hansen, W. Heubner). The contents include standards of physical fitness, psychological examination and

training, character selection; medical care of flying personnel, aeromedical instruction; effects of pharmaceutics on efficiency, anoxia and efficiency; rations and in-flight feeding, stimulants; toxicology of fuels.

Part XII, entitled "Emergency Procedures" (O. Schröder, M. Matthes, K. Schäfer), has three chapters on air evacuation of wounded, organization, equipment, and procedures; air-sea rescue, organization and operation, special hazards; thirst and its control.

Part XIII (K. Büttner, H. Desaga) deals with the effect of air warfare on civilians, with chapters devoted to the physics and the effects of conflagrations, the production of dust by explosions, protective measures and medical problems of dust asphyxsia, and chemically active and inert dusts.

The final section, Part XIV, on the effects of blasts (H. Schardin, T. Benzinger, R. Rössle, H. Desaga), discusses the physical principles underlying the effects of explosions, the physiological effects of blasts in air and in water, the pathological findings in autopsies, clinical experience, and therapeutic measures.

In spite of its large size and broad scope, this work is not (nor does it pretend to be) an exhaustive or even a well-balanced presentation of the whole field of aeromedicine. General editorial supervision was evidently deemed impracticable, and as a result there are some duplications and minor instances of discrepancies. The various parts and individual chapters differ widely in general approach, some authors presenting a monograph in their chosen subject, with upward of a hundred or more references, others giving detailed reports of a few special research projects, or a brief general discussion with very meager factual data and few or no references, these variations in general character being due in part to the nature of the chosen subject. Certain topics, for example, the medical problems related to headward accelerative forces, and the anti-g suit, are not considered at all, and the whole broad field of aviation psychology, and several special subjects (explosive decompression, ejection seats) are poorly represented. Also, very little German work later than 1944 is included, and the references to work outside of Germany are mostly prior to 1940. Naturally some of the reported research has been done better elsewhere or has been superseded by more recent work.

Nevertheless, this book should prove exceedingly valuable to research workers in aeromedicine and to all those who wish to be well informed in the subject; for an organized collection of this magnitude, with all major divisions represented, will no doubt remain unique, it being highly improbable that a similar collection of wartime aeromedical research in the Allied countries will ever be attempted. Although the major divisions of the field were naturally the same in all countries, there were great differences in emphasis. And certain subjects—for example, altitude acclimatization of flying personnel—which were considered important in Germany throughout the war, received relatively little attention elsewhere. The book also contains descriptions of dozens of novel and ingenious techniques and instruments. And the numerous projects that were left incomplete for various reasons offer stimulating suggestions.

Most of the chapters were written in German and translated, with few exceptions, into good idiomatic English. The numerous illustrations, graphs, diagrams, photographs of apparatus and of original recorded data, add greatly to the value of the text. The detailed table of contents compensates somewhat for a rather condensed index.

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Les Hautes Temperatures et Leurs Utilisations en Chimie, 2 vols. P. Lebeau and F. Trombe, Eds. Paris, France: Masson et Cie, 1950. 1,397 pp. 9,000 fr.

This work, compiled by P. Lebeau and F. Trombe with the collaboration of 34 authors, has as its goal the collection of information concerning the production and utilization of high temperatures for chemical purposes. The first 17 chapters are devoted to the discussion of methods used for the production of high temperatures. Included are chapters on flames, solar radiation, electrical resistance furnaces, high-frequency induction furnaces, arc furnaces, vacuum furnaces, etc. The general plan followed in the discussion of each type of furnace is to present the theoretical aspects of the subject, then describe various experimental arrangements that have been used, and finally to mention some of the applications of the particular method described in the chapter. The extent of the theoretical discussion varies considerably in the various chapters, but in general the treatment is adequate. The sections on experimental details include information concerning the properties of the materials used and the behavior of the substances over a wide range of temperatures. For example, the first chapter, which deals with flames, has a detailed discussion of ignition temperatures as a function of composition, limits of inflammability, flame velocities, properties of combustible gases (in tables), dissociation of gases at high temperatures, tables of the enthalpies of common gases from 288° to 5,000° K and flame temperatures. The fifth chapter, which discusses electrical resistance furnaces, presents data on the corrosion of alloys, the flow of alloys under pressure at high temperatures, resistance, and other properties.

The eighteenth chapter describes methods for the measurement of high temperatures, the nineteenth presents methods for the regulation of such temperatures, and the twentieth discusses methods for the study of reactions at high temperatures. The next chapter deals with ceramic studies. Then we find 8 chapters dealing with the properties of substances of interest in high-temperature work. These chapters contain many phase diagrams for two- and three-component oxide systems. The principal oxides discussed are those of silicon, aluminum, chromium, titanium, tin, magnesium, beryllium, calcium, zirconium, and thorium. A discussion of industrial refractory materials, a brief chapter on powder metallurgy, a chapter on very refractory metals, alloys, and metallic compounds follow. The book ends with a set of extensive tables of constants, four appendices dealing with the hydrogen fluorine flame, some supplementary material on the regulation of furnaces, thermal insulators, and a discussion of the temperature scales used in the work reported in the body of the text. Finally we have a 50-page index.

Certainly anyone working with high temperatures will find much of interest to him in these two volumes. On the other hand, he will also find much that he will wish had been eliminated. It is interesting to have descriptions of various furnaces collected in one place, but some of those described here would probably be of more interest to a scientific museum than to a modern research worker. The reviewer believes that the subject matter could have been condensed at least 30 per cent without detracting from the usefulness of the book. Such a reduction should not be applied to all chapters indiscriminately. Thus Chapter 3, on solar radiation, could be eliminated completely without any great loss, whereas many might like to see the chapter on powder metallurgy amplified. Also, it is doubtful that Chapter 12, which discusses the chemical phenomena caused by an electric discharge in a gas, belongs in a book of this type. In spite of these faults the reviewer believes that the book is of such usefulness that it will be a desirable addition to the libraries of those interested in high-temperature work of any kind.

Mechanically the book is excellent. It is well printed on good paper and substantially bound.

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The Chordates. Herbert W. Rand. Philadelphia: Blakiston, 1950. 862 pp. $6.00.

To the field of comparative vertebrate morphology Professor Rand has contributed yet another textbook—a revised and fact-full version of his *Comparative Anatomy*, co-authored with Professor Neal. The present work emphasizes general structure and vertebrate types. In writing this treatise, Rand had in mind "to undertake a book which, to its content of anatomic fact, should add chapters (necessarily brief) giving the reader some knowledge of the history of anatomic science, the ideas and motives which have directed its progress through successive centuries, the theories and principles whereby it has worked, and, above all, an appreciation of its vital human import."

The Chordates, like Gaul, is divided into three parts, and almost as arbitrarily. Part I describes the "basic structure" of vertebrates, after which follow sections on organogenesis and histology. This portion minimizes the comparative viewpoint; it includes, however, much of the content and many of the illustrations of the earlier work by the same author. Part II considers briefly the history, aim, and methods of comparative anatomy. Part III, "Comparative Morphology of the Chordates," is a phylogenetic survey of chordate anatomy and relationships; it presents, by classes, discussions of animal structure, ancestry, phylogeny, and classification, the last relatively simplified. The feeling for comparative anatomy is developed slowly, and the reader has covered all the organ systems and half the book before an insight into comparative principles takes hold. The epilogue states a refreshing case for comparative morphology which, in essence, would have been welcome if proclaimed as an introductory point of view, perhaps in the prologue.

Only high praise can be offered for Rand's command of morphological detail and his erudite presentation of structural relationships. The attractive format, including bold-face type for new terms and many excellent illustrations (a total of 609, approximately half of which were previously published in *Comparative Anatomy*), emphasizes for the student the countless number of facts with which the anatomist must deal.

It would be presumptuous to find fault with a work of this magnitude. Only an occasional lack of emphasis in the presentation seems to mar the decisiveness with which the chordate patterns have manifested themselves. "What is a vertebrate?" is inquired of the reader immediately upon opening the book, and in part this question is answered promptly with discussions of such characteristics as symmetry, body divisions, locomotor appendages, integument, notochord, coelom, and tube-within-a-tube structure. Yet it is not until the succeeding chapter that the branchial clefts are thought worthy of mention, and five chapters later that the dorsal tubular nervous system becomes significant. The evidence pertaining to the origin of the vertebrates is weakly treated, neither the possibility of prechordate affinities with echinoderms or the relationship of vertebrate ancestors to fresh-water jawed placoderms being sufficiently weighed. Finally, some unusual definitions have crept into the context without adequate explanation or derivation: e.g., "molar" and "molecular" activity to designate somatic and visceral nervous functions, respectively.

The Chordates is more than a book on anatomy. It is a morphological treatise supplemented with histological, embryological, paleontological, and historical concepts gleaned from Professor Rand's personal storehouse of information and wide experience as a scholarly teacher. As a standard of reference and a survey of the field it is a worthy contribution and deserves a successful future.

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Variation and Evolution in Plants. G. Ledyard Stebbins, Jr. New York: Columbia Univ. Press, 1950. 643 pp. $8.00.

Professor Stebbins' latest work is indeed a magnum opus—an exhaustive and critical review of data that bear on the evolution of plants. The facts and examples are lucidly presented, and the arguments of which they are the bulwark are cogently and logically developed. The book is clearly the product of acute observation, matured reflection, and a governed imagination. It is an appropriate companion to its distinguished predecessors issuing from the Jesup lectures.

The announced intention is "to discuss the principles and dynamics of evolution" (p. 7). The approach is frankly taxonomic. "The fund of information built up by systematic botanists and zoologists during the past 300 years is the first source of [the evolutionist's] factual data" (p. 4). Stress is placed on comparison of different patterns of evolution in various categories, particularly at the specific level, and an explanation is given in genetic, distributional, and historical terms.

As the title suggests might be the case, the book opens with a discussion of variation. Ten genera of seed plants belonging to 5 families are considered in varied detail, and the differences of pattern between them pointed out. "In *Crepis, Melica, Bromus,* and probably *Wyethia,*" for example, "genetic diversity exists in the form of variants distinguishable when grown side by side under uniform conditions and occupying somewhat different habitats. These are ecotypes in the original sense of Turesson but they cannot be recognized as subspecies because they are not distinguished by morphological differences recognizable over a geographic range of any extent" (p. 70). "The generalization emerging . . . is that we cannot apply uncritically the criteria of species which have been developed in one group to situations existing in another, particularly if the groups are distantly related to each other and have very different modes of life" (p. 71). The methods described for the analysis and demonstration of such patterns will be of particular interest and usefulness to taxonomists.

There follow three chapters covering most of the discussion of the factors pertaining to evolution at the level of actual interbreeding. Chapter III is primarily concerned with a discussion of mutations. Chapter IV deals with natural selection, setting forth the experimental and historical evidence and exemplifying its results by differences of morphology in the genus *Camelina* and the families Compositae and Gramineae. It concludes with a brief discussion of the dynamics of selection and random variation, which, with the examples already cited, is "intended to show that individual variation, in the form of mutation (in the broadest sense) and gene recombination, exists in all populations; and that the molding of this raw material into variation on the level of populations, by means of natural selection, fluctuation in population size, random fixation, and isolation is sufficient to account for all the differences, both adaptive and nonadaptive, which exist between related races and species" (p. 152). Chapter V is concerned with genetic systems as factors of evolution. The principal subjects discussed are the origin and evolution of diploidy, heterokaryosis (an asexual means of combining different genotypes peculiar to certain lower plants), and the relation of growth form, longevity, and the trend in certain plants toward suppression of sexual reproduction. An interesting comparison is made of the effects on the respective genetic systems of plants and animals of differences in longevity, complexity of development, mobility, and the capacity for asexual reproduction.

The remainder of the book is concerned almost wholly with evolution at the specific level, and interspecific relations. The discussion of isolating mechanisms is extensive, concluding with a critique of various hypotheses bearing on the subject. "Our present knowledge of isolating mechanisms therefore supports the statement . . . that descent with modification and the origin of species are essentially different processes . . . and we can conclude that the evolutionist must deal, not with a single process, the origin of species, but with several different processes, the origins of species" (p. 250). The chapter on interspecific hybridization and its relation to the formation of new types is important because of increased evidence relating to this phenomenon. The discussion of introgression between species seems, however, to include an inconsistency, for the author says first (p. 278) "that introgressive hybridization [the context indicates that Stebbins refers here to its effects] is in many ways similar to evolutionary divergence through mutation, recombination and selection" and that it "represents the crossing of genes from one 'adaptive peak' to another and makes possible the formation of gene combinations capable of climbing new 'peaks.'" Yet he says further (p. 279) that "It merely produces convergence between previously more distinct species." This paradox is met with frequently in discussions of introgression.

As one might expect from the author's distinguished research in those fields, the chapters on polyploidy and apomixis, no less than those that treat the evolutionary trends of karyotype and of external morphology, constitute an authoritative and penetrating review of these subjects. The book closes with a discussion of "Fossils, Modern Distributions and Rates of Evolution," and the presentation of a hypotheses concerning rates of evolution. The bibliography is extensive. The illustrations would have gained in clarity had they been printed on smoother paper.

Careful study of this book—and it is assuredly pregnant with opportunity for careful study—can lead only to the realization that it presents for the first time the grand patterns of evolution in the plant world, implicit in the facts of systematics, and interpreted now in the light of genetics and cytogenetics. Zoologists will be grateful that these data and their interpretation are now available for comparison with their own experiences and concepts. One might wish, however, that the author had placed more emphasis on the determinants of evolution at the level of actual interbreeding. It is true that taxonomic data have provided the evolutionist with the first source of his factual data—in a historical sense. They provide the materials for the *patterns* of evolution which the author has so ably delineated. But taxonomic data, the data which determine categories, do not disclose the ultimate determinants of evolutionary process: the factors which determine what particular and different individuals survive to sexual maturity and determine the potentials of recombination, that is, the adaptability, of the breeding groups to which they contribute. These factors are not only genetic, they are ecological as well, for adaptedness and adaptability are relationships of organism and environment. They are not properties of categories but of individuals in relation to their breeding groups. They operate far below the specific level, primarily in populations which accumulating evidence indicates are small, highly localized, and restricted to limited environments. These, not species, are the laboratories of evolution. For it is here and not at the specific level that restriction of gene exchange plays its most important role and determines the adaptability of the existent breeding groups to whatever changes of environment the advent of new species, among other changes, may induce. Professor Stebbins has adum-

brated the study of such populations, but a definitive discussion of their determinants remains to be written. Perhaps this must wait on the accumulation of data, for some of the most critical, especially concerned with the ecological relationships of breeding groups, are lacking. Nevertheless, summation and discussion of such as do exist would greatly advance our understanding of the *processes* of evolution.

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Reviewed in Brief

Cell Physiology and Pharmacology. J. F. Danielli. New York: Elsevier, 1950. 156 pp. $3.00.

For some time it has been apparent that the field of pharmacology needed to be reexamined with a view toward reducing as many experimental observations as possible to the cellular level. Such an approach was attempted by A. J. Clark in 1929, and his book has remained a classic in the field of cellular pharmacology.

In this book, which resulted from a series of lectures given at University College, London, Professor Danielli reexamines the possibilities for physicochemical explanations of the mode of action of drugs at the cellular level. Many may find the analysis too speculative, and surely there is much one could criticize in some of the postulated mechanisms. One cannot deny, however, that the possibilities for the prediction of the pharmacological action of certain types of reagents is quite nicely demonstrated here. If the book does nothing more than cause commercial pharmacologists to give consideration to theoretical possibilities of predicting drug action over the hit-or-miss method of trying thousands of compounds, it will have served a very useful purpose.

The chapters are as follows: The Cell as a Physico-Chemical Unit, Possible Action of Drugs on Surfaces, Membrane Permeability and Drug Action, Enzymes and Drug Action, The Action of Narcotics, and Responses of Cells on the Biological Level.

Pneumoconiosis: Beryllium, Bauxite Fumes, Compensation. Arthur J. Vorwald, Ed. New York: Hoeber, 1950. 659 pp. $7.50.

This volume, dedicated to Dr. Leroy U. Gardner, is a detailed record of the Sixth Saranac Symposium, held September 29 to October 3, 1947. In 1934, Dr. Gardner instituted the first of the series of Saranac Symposia in recognition of the need for informal discussion of problems resulting from the inhalation of dust—not only changes in the lungs (pneumoconiosis), but the industrial and legal phases as well. During the war years a new disease, which appeared to be caused by the inhalation of dust containing beryllium, was recognized among industrial workers. Concurrently with these observations, attention was directed to a disease entity occurring among workers exposed to the fumes arising from bauxite furnaces. The industrial uses of beryllium were so far-reaching that the symposium was organized to obtain a comprehensive and authoritative exposition of present knowledge concerning the disease, its control, and the social and medicolegal implications. Thirty-nine papers were presented, and the discussions evoked are included in the volume. Twenty-nine cover the various aspects of the beryllium problem, 3 are devoted to the subject of bauxite, and 7 contributions are grouped under the heading "Compensation for Occupational Disease." A bibliography of 684 references brings the pertinent literature concerning beryllium up to January 1950.

The approach to the solution of the problem has been an outstanding example of cooperation between science and industry. It is hoped that this series of symposia will be continued and that the deliberations will be presented in the same effective manner as this one has been.

Viruses 1950. M. Delbrück, Ed. Pasadena, Calif.: California Inst. of Technology, 1950. 147 pp. $2.50.

This small volume contains the proceedings of a conference, held at the California Institute of Technology, March 20–22, 1950, on the similarities and dissimilarities among viruses attacking animals, plants, and bacteria, respectively. There are 12 short essays on subjects ranging from bacteriophage to immunological properties of plant viruses. The concluding article, covering 47 pages, is: "A Syllabus on Procedures, Facts and Interpretations in Phage." The book is well printed and well edited. It can be unhesitatingly recommended to all interested in obtaining fundamental knowledge of the viruses.

Scientific Book Register

Advances in Radiochemistry and in the Methods of Producing Radioelements by Neutron Irradiation. Engelbert Broda. New York: Cambridge Univ. Press, 1950. 152 pp. $2.75.

Fundamentals of Acoustics. Lawrence E. Kinsler and Austin R. Frey. New York: Wiley; London: Chapman & Hall, 1950. 516 pp. $6.00.

New Atoms: Progress and Some Memories. Otto Hahn; W. Gaade, Ed. Elsevier, 1950. 183 pp. $1.75.

The Flight of Thunderbolts. B. F. J. Schonland. New York: Oxford Univ. Press, 1950. 152 pp. $3.00.

Textbook of Intermediate Plant Science. George B. Cummins *et al.* Minneapolis, Minn.: Burgess, 1950. 222 pp. $3.25.

Cybernetics: Circular Causal, and Feedback Mechanisms in Biological and Social Systems. Transactions of the Sixth Conference, March 24–25, 1949. Heinz von Foerster, Ed. New York: Josiah Macy, Jr. Foundation, 1950. 209 pp. $3.50.

Introduction to Algebraic Geometry. W. Gordon Welchman. New York: Cambridge Univ. Press, 1950. 349 pp. $4.50.

Modern Chemical Processes. A series of articles describing chemical manufacturing plants by the editors of *Industrial and Engineering Chemistry.* New York: Reinhold, 1950. 222 pp. $4.00.

Machine Shop Methods. Lorus J. Milne. New York: Prentice-Hall, 1950. 376 pp.

News and Notes

It is seldom that SCIENCE *prints two reports on the same meeting. On the other hand, it is seldom that the editors receive reports so diverse in character as the two that follow. The editors are indebted to N. Kleitman, of the Department of Physiology at the University of Chicago, for producing a translation of the report by C. Bykov to accompany the account submitted by Ralph W. Gerard.*

The Eighteenth International Physiological Congress

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The 18th International Physiological Congress, held in Copenhagen August 15–18, was proclaimed a great success by its more than 1,200 members. The Danish hosts, led by Einar Lundsgaard, president (the death of August Krogh, originally named president, was mourned by all), and P. Brandt Rehberg, secretary general, were indefatigable and wise in their preparations, as evidenced in the smoothness of operations. Even the weather favored adventures about this rather New World, Old World city. E. D. Adrian, responding at the banquet for the English-speaking group, could well say that, although each national group would vote its own government best, all would place Denmark so high in democratic living as to give it a top collective rating.

As a result of deliberate encouragement by the Local Committee and of weight of numbers of the American and Empire contingents—over 300 each—English was used predominantly. The Scandinavians, over 250 strong, used this tongue exclusively, as did the Swiss, Dutch, and others. Many of the French and Belgians, well over a hundred, graciously eschewed their language and used English to reach the largest audience. Some of the Italians, perhaps 40, and Spaniards, a big dozen, did likewise. German was heard but little, though 70 or more were present from Germany, and another 30 from other German-speaking countries. The Russians, a baker's dozen, also occasionally shifted from Russian to English and, in contrast to their insularity at the previous meeting at Oxford, conversed freely with colleagues from about the world. In all, more than 40 countries were represented; and some small or distant ones—Algeria, Australia, Egypt, Thailand, and Venezuela come to mind—had surprisingly large contingents.

The scientific sessions included eight symposia, occupying three of the four mornings, and four half-days of individual papers, a total of 540, advancing through ten parallel sections. A schedule of 15–20 papers in an afternoon session allowed but limited discussion, even with a number withdrawn as a consequence of the absence or the courtesy of the authors. The dominant interest of the congress in the nervous system (including muscle and receptors) was clearly shown by the distribution. Five of the eight symposia and nine of the 38 sessions were in this area. Both circulation and nutrition-metabolism were the subject of one symposium and four sessions each. Endocrinology was discussed in three sessions, as were kidney and body fluids. Some 30 demonstrations and 15 movies completed the scientific fare. Papers spread over the usual range of quality but certainly included a number of brilliant reports.

At the business meeting, the Permanent Committee on International Physiological Congresses, on which M. B. Visscher succeeded H. S. Gasser as American member, circulated proposed statutes for an International Union of Physiological Sciences. The plan to form such a union was warmly received by the audience and was especially welcomed by a committee of the American Physiological Society, which had sponsored it pursuant to society vote and in line with the efforts of our late president, H. C. Bazett, until his untimely death on the way to England. That physiology, as all science, is now an important concern of mankind and that an International Union of Physiology is a significant tool for improved understanding between peoples are amply shown by the formal interest taken in this meeting by several governments and by the warm reception given by the mayor. The U. S. ambassador, Mrs. Eugenia Anderson, was especially charming as hostess to a number of American and Danish members of the congress.

The 19th Congress, in 1953, is scheduled for Montreal, probably at the start of September. The many Canadians present observed well the effective meeting arrangements, the convenient and attractively decorated reception and assembly hall, the pleasant entertainments and the various devices for ministering to the needs of the members and their ladies. (Some 200 physicians and others opened their homes to unaccommodated visitors.) That the Canadians will work for an equally felicitous occasion is certain. If the spirit of the world could be like that at such a congress, we should look into the future with confidence. Certainly the one just concluded in Denmark has enriched and encouraged all who participated in it.

Soviet Physiologists at the International Congress

Academician C. Bykov

(From Izvestia, *September 23, 1950)*

During the past academic year there took place two important scientific events: a celebration in connection with the centenary of the birth of the great Russian scientist, I. P. Pavlov, and the session of the Academy of Sciences and the Academy of Medical Sciences of the USSR devoted to the development of the ideas of Pavlovian physiology and medicine.

The joint Pavlovian session attracted a great many participants, representing the different disciplines, including physiology and philosophy. At this session the "theories" which pervert and distort the Pavlovian tendency in science were completely exposed and demolished, and there was also sketched the direction of further development of physiology, medicine, and other disciplines, on the basis of progressive materialistic ideas of Pavlov concerning the highest manifestation of life in the animal and human organism.

Soon after the Pavlovian session, Soviet scientists departed for the 18th International Congress of Physiologists, Pharmacologists and Biochemists.

The congress was convoked in Copenhagen, with over 1,000 physiologists from 37 countries in attendance. This congress, in truth, was not arranged as well as the 15th Congress which took place here in Moscow and Leningrad in 1935, when Pavlov was still alive. However, one must give the physiologists of the Danish capital their due: They invoked all their powers in order to make the congress run in a well-organized manner. This permitted the delivery of 600 papers in 10 sections in the course of less than four days.

Our delegates arrived in Copenhagen two days before the opening of the congress. On the first day there was organized a press conference at the Soviet Legation. There were present numerous representatives of the press, as well as the president of the 18th Congress, the Danish physiologist Professor Lundsgaard.

The arrival of our delegation was widely covered in the Danish press. It was impossible to avoid some cheap and noisy sensationalism of the American style. Correspondents of bourgeois newspapers reported that one could conclude from conversations with a member of the delegation, Academician A. V. Palladin, that the Russians have discovered a new substance which is capable of changing the activity of the brain.

One should note that the aggressive tendencies of the United States of America were also reflected at the International Physiological Congress. Whereas all countries, among them some good-sized ones, sent delegates numbering, as was ours, in tens of participants, there were 400 Americans! One bumped into American "tourists" literally at every turn.

The opening of the congress took place in a building of the university, and was marked by three big plenary sessions. The first one was devoted to the problems of Pavlov's teaching concerning conditioned reflexes, the second to thermodynamics of muscle, and the third to the transportation of ions in the organism.

The most prolific, as the Danes expressed it, discussion was devoted to conditioned reflexes. The presiding English physiologist Adrian remarked that the problem of Pavlovian teaching concerning the activities of the cerebral cortex is less familiar to the physiologists of the world than are other problems.

In my report I illuminated the contemporary status of the Pavlovian materialistic teaching concerning the highest nervous activity, its tremendous importance, the success of Soviet physiologists, and I also subjected to criticism the anti-Pavlovian stands taken by a number of American-English physiologists, particularly the idealistic viewpoints and the incorrect interpretation of Pavlovian teachings on the part of Sherrington, Fulton, and Liddell. The reports of the Soviet delegates were listened to with great attention.

At the same session Dr. Ishlondsky from the United States of America delivered a pallid but highly pretentious talk. In his report, which was of the psychophysiological character, he tried to ascribe certain discoveries made long ago in the Soviet Union, not even to prominent American physiologists, but to himself personally. From Ishlondsky's report it could be seen that American physiological science has a very weak and confused understanding of the highest nervous activities.

The Soviet delegation was constantly surrounded by the care and solicitude of the organizational committee and received the attention of the majority of the young scientists. Respect for Soviet science was also expressed in the selection of three members of the Soviet delegation, Palladin, Koshtoyanz, and Birukov, as presiding officers of the sectional meetings.

The sections worked very diligently. There were reports, demonstrations of experiments and of equipment, and scientific movies. The Soviet film on the genesis of the highest in nervous activity called forth considerable interest and, at the request of a number of delegates, we have shown it twice.

It would not be an exaggeration to say that the reports of the Soviet scientists explaining Pavlov's teaching and the present achievements in this domain left a considerable imprint on the work of the Congress.

The congress demonstrated to the scientific community of the whole world that Soviet physiology, following the only true and progressive Pavlovian road, really occupies a dominant and leading position, and that in the Soviet land, where science enjoys the particular solicitude of the Communist Party, of the Soviet government, and of the great coryphaeus of science, J. V. Stalin, Pavlovian physiology, fighting against idealistic currents, constantly contributes new discoveries to the science of the highest

nervous activity which is connected with, and enriches, medicine.

At the closing of the congress its president, Professor Lundsgaard, in his concluding speech, noted the great importance of the services of Pavlov before the world physiologists and indicated that the Pavlovian materialistic teaching is the only correct road to the solution of the most difficult problems of natural science, namely, the material basis of the psychic processes of man.

The majority of the reports at the sectional meeting were devoted to particular questions and did not contain any great scientific generalizations, nor raise profound physiological problems. Only particular reports of foreign scientists had any interest at all. This applies to the reports in the domain of the investigation of cellular processes and electrical phenomena in living tissues, particularly electrical activity of the cerebral cortex.

One should say that the technique of physiological investigation has become greatly improved over the last few years and that new refined methods of investigation confirmed the profound pronouncement of Pavlov concerning the activity of the cerebral hemispheres.

Individual representatives of the scientific youth of America and England, in their conversations with Soviet delegates, expressed regret that, through the fault of reactionary politicians of their countries, they are deprived of close communion with Soviet scientists. In the opinion of these younger scientists, such communion is highly desirable, in view of the fact that new ideas in science arise particularly in the Soviet land.

The meeting of the permanent International Committee of Physiologists, to which I was invited, found it necessary to recommend that Russian should be one of the official languages at the next congress. At the same meeting there was worked out a constitution of an International Union of Physiologists and of a Permanent Council. The scheme was announced at the last meeting of the congress and then turned over to delegations for further study, with the view of its adoption by the next congress, which will meet at Montreal.

At the termination of the congress, there was a conference of pharmacologists during which the major portion of the time was devoted to reports of the results of investigations of substances concerned in the excitation of the sympathetic nervous system. In contrast to the work of the congress, where there were many reports, at this conference there was a many-sided discussion of just this one problem.

I should like to add that the attitude toward scientific discussion is entirely different abroad than it is here. The so-called discussion at the congress was carried out at a very low level. There was not even a trace of that creative, sharp, critical attitude which marks free scientific discussions here.

During our stay in Copenhagen, and at the invitation of the Danish-Soviet Society, I delivered a lecture on Pavlovian teaching and on the conference that took place in Moscow in June and July, and the member-correspondent of the Academy of Science of the USSR, K. S. Koshtoyanz, reported on the contribution of Russian scientists to the development of world science. The reports met with interest and were followed by a friendly conversation with the progressive physiologists, artists, and writers of Denmark.

Returning from Copenhagen, the Soviet delegation, at the invitation of the Polish scientists, stopped over at Warsaw. In Poland we spent three days. I delivered a lecture about new work in the domain of Pavlovian physiology, at the University of Warsaw. Academician A. V. Palladin, in a comprehensive lecture, reported on chemical processes in the brain under different physiological conditions.

The reports interested the participants of the meeting. The latter expressed a wish to further fortify the scientific and cultural ties between the two friendly nations. Our Polish friends insistently invited Soviet scientists to attend their scientific conferences and meetings and also expressed a wish that Soviet physiologists give special courses on Pavlovian physiology and medicine. Poland, having lost many of its scientists during German occupation, needs, in this respect also, aid from the Soviet Union. Our delegation also visited Krakow and Lodz where they delivered lectures.

One can note with satisfaction that Soviet physiological science is exerting a great influence on the development of physiology in the whole world. Pavlov's ideas permeate scientific work not only in the lands of the peoples' democracy, but also in many capitalistic countries.

VIIth International Congress of the International Society for Cell Biology

John Langdon Brooks

Osborn Zoological Laboratory, Yale University, New Haven, Connecticut

The International Society for Cell Biology convened on September 4 in New Haven, Connecticut, for its VIIth International Congress. The 5-day program included 10 symposia, 6 open sessions, and 1 cinema session. This rather heavy schedule was balanced by a variety of social events. The congress was attended by 392 registrants; the executive committee had directed that attendance be limited to 400 members, if at all possible. Papers were presented by investigators from Belgium, Canada, Denmark, France, Germany, Great Britain, Holland, Italy, Japan, Sweden, Switzerland, and Yugoslavia.

J. S. Nicholas, chairman of the Department of Zoology at Yale, made all arrangements for the congress, serving as chairman and secretary of the Local Committee. The

facilities of Yale University were used for the meetings, and special exhibits had been arranged both in the Sterling Memorial Library and in the Historical Library of the Medical School. Biological apparatus and books were exhibited in the Osborn Zoological Laboratory by various industrial concerns.

The first symposium, held on Monday afternoon, September 4, concerned the "Chemical Organization of Protoplasm." J. F. Danielli served as chairman, and papers were read by D. W. Woolley, A. E. Mirsky, T. Caspersson, and A. Claude. On Tuesday morning T. Caspersson was chairman of the symposium on "Nuclear and Chromosomal Structure." Papers by H. B. Fell and A. F. W. Hughes, J. T. Randall, H. Ris, and A. M. Brues were heard and discussed. The symposium on "Nucleo-cytoplasmic Relations," at which T. M. Sonneborn was chairman, was followed on Tuesday afternoon by a Cinema Session for the showing of 5 films. G. Fankhauser, J. Hämmerling, J. F. Danielli, and W. Duryee spoke at the symposium. Symposia on "Mitosis," H. B. Fell, chairman, and "Cell Nutrition," A. Haddow, chairman, were held simultaneously on Wednesday morning. P. Dustin, M. M. Swann, C. L. Huskins, and D. Marsland presented papers concerned with mitosis. The 4 papers on cell nutrition were given by G. W. Kidder, P. R. White, F. C. Steward and S. M. Caplin, and C. Waymouth. Wednesday afternoon was free, and most delegates took a bus excursion to Amherst. The symposium on the "Fine Structure of Cells" was held on Thursday morning, and papers on "Fertilization" and "Enzymes in Embryos" were presented in simultaneous sessions in the afternoon. E. Fauré-Fremiet was chairman of the morning session. Papers by F. O. Schmitt, L. Monné, S. Mudd, *et al.*, and W. T. Astbury were read. C. Metz was chairman at the consideration of various aspects of fertilization by A. Tayler, J. Runnström, A. Monroy, and Lord Rothschild. Four speakers contributed to the session on enzymes during development: E. J. Boell, S. Ranzi, I. J. Lorch, and D. Mazia; H. Holter was chairman. The last 2 planned sessions, held on Friday morning, were concerned with the "Reproduction of Cytoplasmic Particles" and "Cell Surfaces," respectively. A. Claude was chairman, and R. E. Billingham, B. Ephrussi, A. D. Hershey, and A. Lwoff presented their contributions on the first subject. J. Runnström, president of the society, was chairman at the session when L. R. Blinks, R. Brown, W. Wilbrandt, and M. H. Jacobs considered various aspects of the properties of cell surfaces. At the 6 concurrent open sessions on Friday afternoon, 37 papers on a variety of subjects were read. Chairmen at these sessions were E. N. Harvey and G. Levi, vice presidents of the society, and G. C. Heringa, T. Caspersson, H. Okkels, and P. Weiss, all members of the society's Executive Committee.

E. Newton Harvey, Princeton University, was elected president of the society at the final session on Friday evening. Four honorary members were named: Ross G. Harrison, Warren H. Lewis, Edwin G. Conklin, and Guiseppe G. Levi. Three vice presidents were elected to the International Society: Fauré-Fremiet, H. B. Fell, and G. C. Heringa. J. F. Danielli was renamed secretary-treasurer of the International Society. Ten men were elected to the Executive Committee: J. S. Nicholas, T. Caspersson, H. Okkels, P. Weiss, A. Claude, P. Gaillard, R. Gautheret, F. E. Lehmann, C. Estable, and G. Montalenti.

The International Society for Cell Biology announced that two journals have been established which will be published under the authority of the organization. They are *Experimental Cell Research*, which is edited in Stockholm by Runnström and Caspersson, and the *Annual Review of Cytology*, edited in London by Drs. Bourne and Danielli. The proceedings of the congress are to be published in these journals as regularly submitted papers. The congress announced also that it is in the process of setting up a commission to issue reports on cytochemistry. This organization will be concerned with the regularizing and organizing of the field of research.

Scientists in the News

Karl T. Compton, chairman of the Corporation of MIT, was elected chairman of the Scientific Research Society of America by the Board of Governors at its meeting in New York, December 1. Dr. Compton will succeed **George A. Stetson** on July 1. RESA was organized under the sponsorship of Sigma Xi in 1948 and has at the present time 10 branches and clubs and, in addition, a membership-at-large of 300.

Recent visitors at the National Bureau of Standards were: **J. Blears**, Metropolitan-Vickers, Manchester, England; **Enrique Chacon**, University of Deusto, Bilbao, Spain; **Ken-Ichi Maeda**, Electrical Communication Laboratory, Ministry of Telecommunications, Tokyo; and **Yoshimi Yamaguchi**, Nissin Chemical Co., Osaka. The following members of a mission from Germany, under the auspices of ECA, visited the rubber section: **E. Bobeth**, Phoenix & Co., Harburg; **W. Kramer**, Deutsche Dunlop Gummi Compagnie, Hanau; **Wilhelm Kunst**, Vorwerk und Sohn; **F. Paasche**, Clouth, Rheinische Gummi Fabrik, Cologne; **A. Titze** and **Detlev Schmidt**, German Rubber Manufacturers Association, Frankfort; **T. R. Schmausser**, Englebert & Co., Aachen; **Walter Heinz Vieweg**, Metzeler Gummiwerke; and **G. A. Schwirsch**, Pahlische Gummi- & Asbest-Gesellschaft, Dusseldorf-Rath.

Leon Herman, of the Observatory of Paris, is a visiting research fellow at the University of Alaska for 1950–51. Dr. Herman is a spectroscopist and is interested in the aurora and airglow.

Dag Knutson, head of the University Polyclinic for Internal Diseases at the Carolinian Hospital, Stockholm, was elected president of the World Medical Association at its fourth annual general assembly in New York. Dr. Knutson will take office at the fifth assembly to be held in Stockholm in September 1951. He succeeds **Elmer L. Henderson**, president of the American Medical Association.

W. Graham Keyworth, plant pathologist at the East Malling Research Station, Kent, England, will spend a year as visiting scientist on the staff of the Connecticut Agricultural Experiment Station. Dr. Keyworth will continue his studies of

Verticillium and *Fusarium* wilt diseases, and plans to visit hop-producing areas in the U. S.

Victor K. La Mer, professor of chemistry at Columbia University, has been appointed honorary professor of the faculty of chemistry at the Universidad Nacional Mayor de San Marcos de Lima, Peru, where he recently lectured on aerosols.

Pascoal Mucciolo, professor of veterinary medicine, University of São Paulo, Brazil, is spending a year with the American Meat Institute Foundation, University of Chicago, on a Rockefeller Foundation fellowship. He is engaged in research in the Division of Bacteriology with **C. F. Niven, Jr.**

Hayden C. Nicholson, who has served as executive secretary of the NRC Committee on Growth for the past three years, has resigned to become dean of the School of Medicine at the University of Arkansas. **O. Malcolm Ray**, formerly professional associate with the committee, has been appointed executive secretary, and **Charles E. Richards**, of the Cleveland Clinic, is now professional associate.

I. S. Ravdin, William S. McCann, and **Francis C. McLean** have been appointed to the Committee on Medical Sciences of the Research and Development Board. Dr. Ravdin has been John Rhea Barton professor of surgery at the University of Pennsylvania since 1945; he is also director of the Harrison Department of Surgical Research and surgeon-in-chief of the University Hospital. Dr. McCann has been Charles A. Dewey professor of medicine at the University of Rochester and physician-in-chief of the Strong Memorial and Rochester Municipal Hospitals since 1924. Dr. McLean has been associated with the University of Chicago since 1923, as professor of medicine and of pathological physiology.

Bengt Strömgren, director of the University of Copenhagen Observatory, has accepted an appointment with the University of Chicago as professor of astronomy, to succeed **Otto Struve**, now at the University of California. Dr. Strömgren will also be chairman of the Department of Astronomy and Astrophysics and director of the Yerkes and McDonald Observatories. He was recently awarded the first Augustinus Prize by the vice chancellors of the Universities of Denmark for his accomplishments in astronomy and astrophysics.

Norman H. Taylor, chief of the Soil Survey and assistant director of the Soils Bureau, Wellington, New Zealand, is studying soils and research methods with scientists of the Division of Soil Survey, USDA, and is visiting several soil research institutes in the U. S. and Canada.

Meetings

The 57th annual meeting of the **American Mathematical Society** will be held at the University of Florida, December 27–29, in conjunction with the annual meeting of the **Mathematical Association of America**, and the Christmas Conference of the **National Council of Teachers of Mathematics**. The Josiah Willard Gibbs Lecture will be delivered on Wednesday, December 27, by G. E. Uhlenbeck, of the University of Michigan, on "Some Basic Problems of Statistical Mechanics."

The University of Florida's midwinter **Seminar in Ophthalmology and Otolaryngology** will be held at Miami Beach, January 15–20. The lectures on otolaryngology will be presented January 15–17, and those on ophthalmology, January 18–20. The Southern Section of the American Laryngological, Rhinological and Otological Society will meet at the university on January 17.

The American Institute of Electrical Engineers will meet at the Hotel Statler, New York, January 22–26. Among the 60 technical sessions planned is one sponsored by the Committee on Telegraph Systems, in which papers will be presented on an electronic time division multiplex telegraph set, a teleprinter signal bias meter, and a nationwide telegraph system using frequency-modulated carrier equipment. Inspection trips to industrial points of interest will be a feature of the meeting.

A **two-week advanced medical course in radioisotope work** will be given by the Oak Ridge Institute of Nuclear Studies beginning February 5. The course is intended for research workers in the field of medicine who have had some experience in the basic techniques of using radioisotopes. The first week will be devoted to lectures and laboratory work on radioisotopes in therapy; the second week, to use in clinical tracer studies. A fee of $25 will be charged for the course. Applications may be obtained from Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P. O. Box 117, Oak Ridge, Tenn.

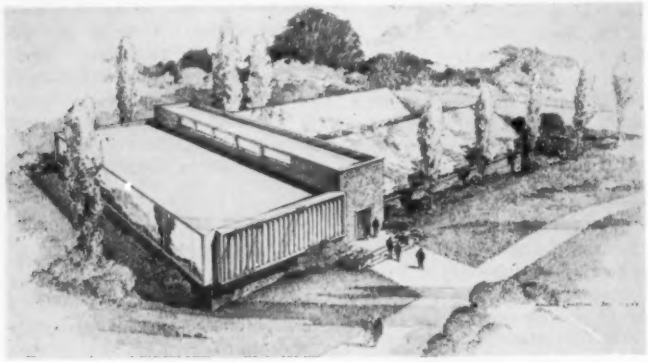
Colleges and Universities

A 15-cubic-foot super deep-freeze, perhaps the largest cold box known, which cools its contents to −452° F and can hold them there indefinitely, has been designed and built by Samuel C. Collins, professor of mechanical engineering at **MIT**. The new low-temperature machine, developed in the low-temperature research laboratories with funds provided by the Navy Bureau of Ordnance and ONR, operates by compressing, regeneratively cooling, and then expanding helium gas until a portion of the gas turns into a liquid just 7½° above absolute zero, theoretically the lowest possible temperature.

William W. Engstrom was one of three assistant professors named to the staff of the School of Medicine at **Marquette University**, Milwaukee. A specialist in glandular disorders and the first endocrinologist in Milwaukee, he was formerly associated with Yale. Others appointed were John E. Steinhaus, Department of Pharmacology, who recently completed requirements for the Ph.D. degree at the University of Wisconsin; B. Wesley Catlin, former associate in research at Carnegie Institute, Long Island, N. Y.; and Michael W. Shutkin, attending physician at Mount Sinai Hospital, Milwaukee.

The open-air exposure method of treating extensive burns has been demonstrated at the **University of Texas** Medical Branch, Galveston.

Arranged by T. G. Blocker, Jr., professor of plastic and maxillofacial surgery, the meeting was attended by A. B. Wallace, of the College of Surgeons, Edinburgh; Patrick Clarkson, Guys Hospital, London; Gunnar Thorsin, Stockholm; Hussni Higazi, University of Cairo; and Leonard Colbrook, London.



PLANT PHYSIOLOGY BUILDING OF THE LOS ANGELES division of the University of California's College of Agriculture, which is nearing completion. This $200,000 structure will house temperature-control rooms, darkrooms, soil sterilizing rooms, potting rooms, and other special laboratories, all stocked with the latest equipment. In this building the university plans to carry on extensive research in one of the most important phases of agriculture.

Experiments in which boron was formed by bombarding lithium with alpha particles were reported at the annual winter meeting of the American Physical Society by three **Illinois Institute of Technology** physicists. Bert J. Toppel, William E. Bennett, and Paul Roys reported that alpha particles formed from ionized helium gas had entered the lithium nucleus by fusion to form boron, a hitherto unreported case of transmutation through nuclear reaction. The results are said to have no immediate applied significance, but they do give another clue to the action of nuclei in the "excited state."

Fellowships

Applications are invited by Radcliffe College for the **Helen Putnam Fellowship for Advanced Research**, open to postdoctoral women in the field of genetics or of mental health, broadly defined to include such fields as clinical psychology and child development. The stipend will be $2,800 a year, with possibility of renewal. Applicants should be prepared to submit a plan of research, and preference will be given to those whose research is already under way. Blanks, which should be returned not later than *April 1*, may be obtained from the Secretary of the Graduate School, Radcliffe College, Cambridge, Mass.

The **Harry Bateman Research Fellowships in Pure Mathematics** at the California Institute of Technology for postdoctorate work are being offered. Recipients will devote the major part of their time to research but are expected to teach one upper-class course in mathematics. The stipend is $3,600 for the academic year. For application blanks and further information, address Dean of the Faculty, California Institute of Technology, Pasadena 4. Applications must be returned before *February 15*.

Under a plan for coordination in the teaching of the sciences **Bryn Mawr College** is offering five graduate fellowships and scholarships for 1951–52. Three scholarships of $700 each are offered to qualified students who have had undergraduate training in two or more of the natural sciences and who wish to continue study in the fields of biochemistry, biophysics, crystallography, geochemistry, geophysics, or psychophysics, and others. Two fellowships of $1,250 each are offered to candidates in the same fields who, in addition to undergraduate training, have had at least a year of graduate work in science. In addition, research fellowships may be awarded to qualified students, the value to be determined by the qualifications of the candidate. Application should be made to the Office of the Dean of the Graduate School by *March 15*.

Funds have been made available for one or more **Charles LeGeyt Fortescue Fellowships** in electrical engineering for 1951–52. The postgraduate awards of $1,000–$1,500 a year will be made to students from recognized technical schools in the U. S. and Canada. Application forms may be obtained from the deans or chairmen of Departments of Electrical Engineering in the various engineering schools, or from H. H. Henline, Secretary, American Institute of Electrical Engineers, 33 W. 39th St., New York 18, and must be submitted by *February 15*.

Grants and Awards

The Kurt Lewin Memorial Award for 1950 was presented to Gordon W. Allport at the annual meeting of the American Psychological Association. The award is made annually to "the person who has contributed most significantly to the development and integration of psychological research and social action." Gustave M. Gilbert received the **Edward L. Bernays International Tensions Award**, for contributing to the reducing of international tensions.

The Memphis Chapter of the **American Heart Association** has provided $1,400 to support research in the Division of Physiology, University of Tennessee. The fund is being used by Lester Van Middlesworth, to investigate the ameliorating influence of hypothyroidism on hypertension, and by Donald B. Zilversmit, in a study of the role of phospholipides in the deposition of arterial lipids.

The Viking Fund has appropriated more than $183,700 to aid research and education in anthropology and related sciences. Eight awards are for field research to be conducted by American scholars in

Tunisia, Central Africa, Iraq, Iran, New Caledonia and the Marianas. Eleven grants are to scholars and institutions in Mexico, Norway, Great Britain, Austria, India, Indonesia, and Australia. Additional grants in the U. S. will aid 19 colleges, universities, and scientific institutions in 14 states and the District of Columbia. Approximately $101,000 of the funds will support projects in archaeology, physical anthropology, personality and culture studies, ethnology, anthropologic theory, and education.

The American Anthropological Association announces the establishment of the **Alfred Vincent Kidder Award.** The medal, to be awarded every three years for achievement in American archaeology, is named for Alfred V. Kidder, a member of the Peabody Museum, who retired recently as chairman of the Division of Historical Research of Carnegie Institution of Washington. An award committee is working on the selection of the winner of the 1950 medal.

V. C. Finch, of the University of Wisconsin, received the **Distinguished Service Award** of the National Council of Geography Teachers at its annual meeting, November 24. **The Journal of Geography Prizes** for outstanding articles published in the *Journal* in recent years were awarded to E. Willard Miller, of Pennsylvania State College, and William B. Brierly, Army Map Service, Washington, D. C. George J. Miller, recently retired from Indiana University, who served for 30 years without pay as editor of the *Journal of Geography*, was honored by the council, of which he was a founder and secretary for its first 12 years.

Three dental research awards, totaling $13,176, have been made by the Public Health Service. Paul H. Keyes, associate in clinical dentistry at Harvard School of Dental Medicine, will make studies to determine a chemical diet for hamsters most conducive to the development of tooth decay. Raymond L. Hayes, of the Howard University College of Dentistry, will investigate the metabolism of ascorbic acid in relation to the periodontal diseases. The role of the metabolism of cartilage in the normal and abnormal growth of the jaw will be studied by Bernard G. Sarnat, head of the Department of Oral Surgery, University of Illinois.

Barnett F. Dodge, professor and head of the Department of Chemical Engineering, Yale University, received the **William H. Walker Award** of the American Institute of Chemical Engineers on December 5. The award was made "in recognition for his outstanding contributions to the literature of chemical engineering over the years." Dr. Dodge was especially cited for his work on the manufacture of oxygen and his thermodynamic studies.

NRC News

The **Committee on Growth** of the National Research Council, acting for the American Cancer Society, is accepting applications for *Damon Runyon Senior Clinical Research Fellowships*, which are financed by a grant of $110,000 from the Damon Runyon Memorial Fund. Applications should be filed before *March 1*, on behalf of the applicant, by the institution where he will be in residence. Applications will be considered in April, and fellowships ordinarily will begin July 1, although this date may be varied at the request of the fellow. Awards are made directly to the institution on an annual basis, and renewal may be requested. Individuals now holding these fellowships will be notified regarding applications for renewal. Communications should be addressed to Executive Secretary, Committee on Growth, National Research Council, 2101 Constitution Ave., N.W., Washington 25, D. C.

The **Committee on Human Reproduction** of the National Research Council will hold its annual conference January 19–20 at the Hotel Commodore, New York. The subject will be pregnancy wastage. Speakers will include G. W. Anderson and R. Nesbitt, Johns Hopkins Hospital; L. Baumgartner and E. Shoor, Cornell University Medical College; L. E. Casida, University of Wisconsin; G. W. Corner and A. I. Csapo, Carnegie Institution; S. H. Clifford, A. T. Hertig, and C. A. Villee, Harvard Medical School; E. C. Hughes, Syracuse University Medical Center; J. W. Jailer and H. C. Taylor, Jr., Columbia University College of Physicians and Surgeons; P. Levine, Ortho Research Foundation; E. Potter and M. E. Vavis, University of Chicago; C. Tietze, National Committee on Maternal Health; and W. C. Young, University of Kansas.

Miscellaneous

Proposals for basic research in the various areas of biochemistry are now being accepted by the **Biochemistry Branch, Office of Naval Research,** for consideration at the winter (study and evaluation) meeting of its Advisory Panel. For further information address: Chief of Naval Research, ONR, Department of the Navy, Washington 25, D. C. Attention: Biochemistry Branch, Code 442.

A new Bureau of Mines lignite laboratory, the first to be built exclusively for lignite research, has been completed in Grand Forks, N. D. The building provides facilities for studying methods of increasing the use of lignite for power, heat, and other purposes, and research will include preparation and drying. Lignite reserves in the U. S. are estimated at 939 billion tons. The work of the new laboratory is expected to help in the better utilization of this practically untouched resource.

A color photography display has been planned for the new Mannes and Godowsky room at **George Eastman House.** Details of the display, made possible by a $25,000 gift from Leopold Godowsky and Leopold Mannes, co-inventors of Kodachrome film, are being planned by a committee of color experts in Rochester. The display will be designed to show visitors the meaning of color and to explain the main attempts that have been made to reproduce colors photographically. Push-button models and diagrams, as well as actual color photographs and apparatus, will be used to dramatize the story. Preliminary groupings call for complete material on vari-

ous historical and modern aspects of color, including the nature of light and color; principles of color photography; additive color photography; mosaic screen processes; subtractive color photography; Carbro printing; dye transfer; Technicolor; making of color separation negatives; multilayer color processes; Kodachrome film; Ektachrome, Agfacolor, and Anscocolor; and color negative, dye bleach, and interference processes.

An exhibit honoring Hermann von Helmholtz, inventor of the ophthalmoscope, will be on display for six months, beginning December 17, at the Armed Forces Medical Museum, Washington, D. C. The museum's collection illustrates the development of the ophthalmoscope from the Helmholtz drawings to the modern electrified instrument. A rare three-dimensional ophthalmic atlas, designed about 1870 for training students, foreign and American contemporary atlases, and illustrations will also be shown.

The new assistant to the president of **Horizons Incorporated,** Princeton, N. J., is Robert Gordon McAllen. He formerly served on General MacArthur's staff dealing with military government control of the Japanese Educational System. J. L. Snoek, formerly with the Philips Company in Eindhoven, Holland, and an authority on ferromagnetism, has been appointed head of the Physics Department.

The National Registry of Rare Chemicals, 35 W. 33rd St., Chicago 16, lists these wanted chemicals: iodine heptafluoride; trichlorogermane; chromium carbonyl; titanium difluoride; cuprous fluoride; anthracene-2-sulfonic acid; 2,3-dihydroxyanthracene; carbon tetraiodide; 2,6-epoxyhexane; 3-fluorophenylalanine; tribromobutane; camphane aldehyde; *p*-methoxythiophenol; maleimide; ketomalic acid; 3-hydroxynorcholinic acid; ionene; lysergic acid; neurine; and promulein.

Norman M. Howden, a newspaperman for 17 years, and Rachel L. Carson, a writer of scientific articles and books for 13 years, will receive the **AAAS-George Westinghouse Science Writing Awards** for the best science writing of 1950. Mr. Howden is science writer on the Rochester (N. Y.) *Democrat and Chronicle,* and Miss Carson, of Silver Spring, Md., is editor-in-chief of the U. S. Fish and Wildlife Service and a free-lance writer.

The awards will be presented at a luncheon on December 28 in Cleveland, Ohio, during the annual meeting of the AAAS. Mr. Howden will receive $1,000 for what the board of judges considered the best newspaper science writing of 1950, and Miss Carson for the best magazine science writing of the year. The judges also announced two honorable mention citations in the newspaper field: Robert Goldman, now of the New York *Post,* was a member of the staff of the Detroit *Free Press* when he wrote his series of feature articles on heart disease; Robert K. Plumb, of the New York *Times,* wrote his honorable mention story on an Indian earthquake. Eugene Kinkead, of Chappaqua, N. Y., an editor of *The New Yorker,* won honorable mention in the magazine field for his article on Professor Petrunkevitch, a spider specialist.

Mr. Howden's article, "Cancer Problem Riddle May Be Discovered in Carrots, Coconut Milk," appeared in the Rochester *Democrat and Chronicle* on September 24, 1950. It described an unusual research project in progress in a botany laboratory at the University of Rochester and told how a small bit of carrot, bathed in a solution containing the proper plant foods, with a few drops of coconut milk added, undergoes the same sort of rapid, uncontrolled growth that characterizes cancer. Mr. Howden, born in Fillmore, N. Y., and graduated from Fillmore High School, received A.B. and M.A. degrees from the University of Rochester. He began his newspaper career in 1933 as a reporter on the *Democrat and Chronicle.*

Miss Carson's article, "The Birth of an Island," appeared in the autumn 1950 issue of *The Yale Review.* It describes the volcanic origin of islands and their subsequent colonization by plant and animal life. Miss Carson was born in Springdale, Pa., and received an A.B. degree from Pennsylvania College for Women and an M.A. degree from Johns Hopkins. Since she wrote her first magazine article in 1937 she has contributed to *Collier's, Reader's Digest, Coronet,* and other leading publications. She is the author of *Under the Sea Wind,* published by Simon & Schuster in 1941, and of "The Sea Around Us," soon to appear in abridged form in *The New Yorker* prior to publication as a book by Oxford University Press. Her prize-winning story will be one of the chapters in that book. Miss Carson joined the Bureau of Fisheries in 1936 as an editor, and in 1949 she was made editor-in-chief of the Fish and Wildlife Service.

Publications Received

Bibliography of Scientific Publications of South Asia (India, Burma, Ceylon) January–June, 1949. Unesco, Science Cooperation Office for South Asia, University Buildings, Delhi, India.

Otto Friedrich Müller's Zoologica Danica. Vol. 1. Library Research Monographs. Jean Anker, Ed. Ejnar Munksgaard, 6 Nörregade, Copenhagen, Denmark.

A Generic Revision of Achilidae (Homoptera; Fulgoroidea) with Descriptions of New Species. R. G. Fennah. Vol. 1, No. 1. 10s. ***A Revision of the Family Cercacidae (Lepidoptera Torticoidea).*** A. Diakonoff. Vol. 1, No. 2. 10s. ***The Early Literature on Mallophaga,*** Part I. Theresa Clay and G. H. E. Hopkins. 10s. British Museum (Natural History), Cromwell Road, London S.W. 7.

Catalogue of the Positions and Proper Motions of 5583 Stars. Ida Barney. Trans. of the Astronomical Observatory of Yale University. Vol. 21. New Haven, Conn.

Researches on the Radiotherapy of Oral Cancer. C. A. P. Wood and J. W. Boag. Medical Research Council Special Report Series, No. 267. British Information Services, 30 Rockefeller Plaza, New York 20.

PERSONNEL PLACEMENT

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1. Rate: 15¢ per word, minimum charge $3.00 for each insertion. If desired, a "Box Number" will be supplied, so that replies can be directed to SCIENCE for immediate forwarding. Such service counts as 10 words (e.g., a 25-word ad, plus a "Box Number", equals 35 words). All ads will be set in regular, uniform style, without display; the first word, only, in bold face type.

For *display* ads, using type larger or of a different style than the uniform settings, enclosed with separate border rules, the rate is $16.00 per inch; no extra charge for "Box Numbers".

2. Advance Payment: All Personnel Placement ads, *classified* or *display*, must be accompanied by correct remittance, made payable to SCIENCE. Insertion can not be made until payment is received.

3. Closing Date: Advertisements must be received by SCIENCE, 1515 Mass. Ave., N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

POSITIONS WANTED

Academic Position: Ph.D. Teaching, research, or departmental responsibilities in medical school, college, or university. Bacteriology, mycology, parasitology, public health, histology, and biology. 15 years teaching experience, several publications; honor and professional societies. Available January or September 1951. Box 378, SCIENCE. X

Biochemist—Experienced in supervising industrial production pharmaceuticals. Desire production position having responsibilities commensurate with background. Well recommended. Box 379, SCIENCE. X

Biochemist-Physiologist, Ph.D. June '51. Desires academic position combining teaching and research. Independent investigator—leading eastern university two years. Publications. References. Location immaterial. Box 380, SCIENCE. X

Biologist—M.A. plus 3 years graduate study in botany, geology. 4 years teaching includes advanced geology, vertebrate zoology, at teachers and liberal arts colleges. Experience in agricultural research, midwest. Available, February. Any location. Box 381, SCIENCE. 12/29

Botanist: Ph.D. Available February '51 desires teaching, research position. Ecology, systematics, morphology, anatomy, general botany. Box 387, SCIENCE. X

Geneticist-Cytologist: Ph.D. Desires teaching position with time for research. Academic training botany, plant physiology, chemistry, 3 years cancer research with animals. References, publications. Box 388, SCIENCE. X

Physiologist: M.S. Cornell University, desires teaching or research position. Experience in teaching and research fields. Interest: metabolism and endocrinology. Available immediately. Box 382, SCIENCE. X

Research Director, M.D., Ph.D. (Chem.), certified Path; hospital, teaching, organizing, research experience for twenty years, on 100 publications; age 44 years. Box 386, SCIENCE. X

Statistician to large food corporation seeks responsible appointment with vigorous industrial or academic research group. Exceptionally wide experience in applying and developing statistical method and design to all kinds of research and other problems in the field of Biochemistry, Food Technology, Chemical Engineering, Instrumentation, Quality Control, Psychometrics, Biometrics, Medicine, Population Sampling, etc. Originally qualified as Biochemist. Good knowledge of Social Sciences. Publications. Box 311, SCIENCE. X

Veterinarian, M.S. in bacteriology and animal pathology desires research or academic position. Teaching experience. Veteran. Box 383, SCIENCE. X

Wanted—College teaching or research post in biochemistry or plant physiology; Ph.D. in agricultural biochemistry (Minor: Plant Physiology); three years, research chemist in industry; for further information, please write Science Division, Medical Bureau (Burneice Larson, Director), Palmolive Building, Chicago. X

PERSONNEL PLACEMENT

POSITIONS OPEN

Bacterial Protein Synthesis; research opening, Philadelphia early 1951, young Ph.D. Give background, date available; snapshot appreciated. Box 384, SCIENCE. 1/5

Biologist: Ph.D. Young man as collaborator on research project, screening antitumor agents. Box 374, SCIENCE. X

Microbiologist: One to three years post Ph.D. preferred. Superior training in microbial physiology and biochemistry required; experience with enzyme preparations and modern biochemical techniques desirable. Fundamental research in government supported laboratory. Please give resume training, publications. Box. 385, SCIENCE. 12/29

Positions Open:
(a) **Neurophysiologist,** Ph.D., with extensive experience; physiologist, Ph.D. with minor in endocrinology or pharmacology and, also, two physiologists with Bachelor degrees; research department, new psychiatric unit, large teaching hospital; medical center. (b) **Biochemist,** Ph.D., with sound knowledge of bacteriology, to serve as assistant director of research, pharmaceutical company; East. (c) **Pharmaceutical chemist** for assistant research directorship; industrial company; advantageous if experienced in perfumes, flavors; $5,000–$6,000; East. (d) **Immunochemist** interested in research in rheumatic fever and general field of allergy and, also, physiologist interested in pediatric research; large teaching hospital; university medical center, Midwest. (e) **Physiologist;** Ph.D., or physician to direct department of literary research; administrative ability required; large organization; East. (f) **Bacteriologist;** qualified to direct research division, large pharmaceutical company; Ph.D. required; sound knowledge of growth of bacteriology, moles, as used in production of penicillin and of production methods required; around $8,000. S12-4 Science Division, Medical Bureau (Burneice Larson, Director), Palmolive Building, Chicago. X

The MARKET PLACE

CHARGES and REQUIREMENTS for "MARKET PLACE" Ads

1. Rate: 20¢ per word for *classified* ads, minimum charge $5.00 for each insertion. Such ads are set in uniform style, without display; the first word, only, in bold face type. For *display* ads, using type larger or of a different style than the uniform classified settings, and entirely enclosed with separate rules, rates are as follows:

Single insertion	$17.50 per inch
7 times in 1 year	16.00 per inch
13 times in 1 year	14.00 per inch
26 times in 1 year	12.50 per inch
52 times in 1 year	11.00 per inch

2. Payment: For all *classified* ads, payment in advance is required, before insertion can be made. Such advance remittances should be made payable to SCIENCE, and forwarded with advertising "copy" instructions. For *display* advertisers, monthly invoices will be sent on a charge account basis—providing satisfactory credit is established.

3. Closing Date: Classified advertisements must be received by SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., together with advance remittance, positively not later than 14 days preceding date of publication (Friday of every week).

For proof service on display ads complete "copy" instructions must reach the publication offices of SCIENCE, 1515 Massachusetts Avenue, N.W., Washington 5, D. C., not later than 4 weeks preceding date of publication.

LANGUAGES

LINGUAPHONE MAKES LANGUAGES EASY
At home learn to speak Spanish, Portuguese, Italian, French, German, Russian, by quick easy Linguaphone Conversational Method. Save time, work, money. Send for free book today. **LINGUAPHONE INSTITUTE, 84-W Radio City, New York 20.**

YOUR advertisement in these columns reaches

The MARKET PLACE

BOOKS

Your sets and files of scientific journals are needed by our library and institutional customers. Please send us lists and description of periodical files you are willing to sell at high market prices. J. S. CANNER AND COMPANY, 909 Boylston Street, Boston 15, Massachusetts. tf

Send us your Lists of tf
SCIENTIFIC BOOKS AND PERIODICALS
which you have for sale.
Complete libraries; sets and runs; and single titles are wanted.
Also please send us your want lists.
STECHERT-HAFNER, INC., 31 East 10th Street, New York 3.

WANTED TO PURCHASE:
SCIENTIFIC PERIODICALS
Sets and runs, foreign and domestic
SCIENTIFIC BOOKS
Entire libraries and smaller collections
WALTER J. JOHNSON
125 East 23rd Street, New York 10, N. Y.

PROFESSIONAL SERVICES

FOOD RESEARCH LABORATORIES, INC.
Founded 1922
Philip B. Hawk, Ph.D., President
Bernard L. Oser, Ph.D., Director
Research • Analyses • Consultation
Biological, Nutritional, Toxicological Studies for the Food, Drug and Allied Industries
48-14 33rd Street, Long Island City 1, N.Y.
• RESEARCH
• CONSULTATION
• ANALYSES

SPECIAL GLASS APPARATUS
Our glass blowing department is available for special scientific and technical glass apparatus made to specifications and drawings. Inquiries invited. Estimates furnished.
E. MACHLETT & SON
218 East 23rd St. New York 10, N. Y.

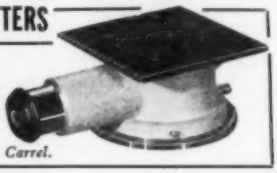
CHEMICAL CONSULTATION, RESEARCH, DEVELOPMENT
THE PANRAY CORP.
Research Division
340 CANAL ST., NEW YORK 13
• Microanalysis (C, H, N, S, Etc.)
• Custom Organic Syntheses
• Chemotherapeutics
• Sponsored Research

SUPPLIES AND EQUIPMENT

GLYCOCYAMINE—Hydroxyproline, L-Methionine
• AMINO ACIDS • BIOCHEMICALS
• PRE-MIXED MICROBIOLOGICAL ASSAY MEDIA
H. M. CHEMICAL COMPANY, LTD.
144 North Hayworth Avenue Los Angeles 36, California

The MARKET PLACE

SUPPLIES AND EQUIPMENT

ROGER* BEAM SPLITTERS
• 70% TRANSMISSION
• 30% REFLECTION
ROLAB PHOTO-SCIENCE LABORATORIES
Sandy Hook, Connecticut

* *Formerly with Dr. Alexis Carrel.*

LABORATORY ANIMALS
• Clean healthy well-fed animals
• Guaranteed suitable for your needs.
Reasonably priced—Dependable service
DOGS RATS RABBITS
CATS PIGEONS HAMSTERS
MICE POULTRY GUINEA PIGS
JOHN C. LANDIS • Hagerstown, Md.

All Amino Acids (natural, synthetic, unnatural), Rare Sugars, Biochemical Products, Reagents, New Pharmaceuticals in stock. Write or phone PLaza 7-8171 for complete price list.
BIOS LABORATORIES, INC. 17 West 60th Street, New York 23, N. Y.

INDEX of REFRACTION LIQUIDS
• Valuable Aid for Identification of Minerals and other Solids by the Immersion Method of Microscopy
• Range 1.400-1.700, intervals of 0.002, or as selected Index Certified to ± 0.0002
• Range 1.71-1.83, intervals of 0.01
Write for Price List Nd-SM
R. P. CARGILLE 118 Liberty Street, New York 6, N. Y.

White SWISS Mice 20c
Rabbits, Cavies, White Rats, Ducks, Pigeons, Hamsters
Write • J. E. STOCKER • Ramsey, N. J.

STAINS
STARKMAN Biological Laboratory
• RARE
• COMMON
Price list on Request
461 Bloor St., W.
• Toronto, Canada

SINCE 1870
Bacteriologists
Chemists • Pharmacologists
New Food Ingredients • New Drugs
ANIMAL TESTS
Analyses • Consultation • Research
LaWall & Harrisson
Div. S, 1921 Walnut St., Philadelphia 3, Pa.

more than 32,000 scientists - at a very low cost

HOTEL RESERVATIONS

117th AAAS MEETING

Cleveland, December 26-30, 1950

The list of hotels and the reservation coupon below are for your convenience in making your hotel room reservation in Cleveland. Please send your application, *not* to any hotel directly, but to the Housing Bureau of the Cleveland Convention and Visitors' Bureau to avoid delay and confusion. The experienced Housing Bureau will make assignments promptly and the hotel will send a confirmation directly to you in two weeks or less. **Please plan to share a room with a colleague.** In addition to economy, this will insure ample accommodations for all in the *downtown* hotels. Mail your application *now* to secure your first choice of desired accommodations.

HOTELS AND RATES PER DAY

Hotel*	Single	Double	Twin-Bedded	Suites
STATLER	$4.00–$8.00	$7.00–$10.00	$8.50–$12.50	$17.00–$23.00
HOLLENDEN	$3.50–$8.00	$5.50–$10.00	$7.00–$12.00	$12.00–$22.00
CARTER	$4.00–$6.50	$6.00–$10.00	$7.00–$10.00	$18.00–$25.00
ALLERTON	$3.50–$7.00 $2.50 RW	$6.00–$ 9.00	$6.00–$10.00 $4.00 RW	$10.00–$20.00
AUDITORIUM	$3.50–$5.00	$5.50–$ 7.50	$7.50	$12.50–$26.00
OLMSTED	$3.00–$6.00	$5.00–$ 9.50	$7.00–$ 9.50	$10.00–$15.00

Prices are subject to change, but are not likely to do so.

RW means running water only—no private bath.

* A list of the headquarters of each society and section is under **Association Affairs**, SCIENCE, August 25 and in THE SCIENTIFIC MONTHLY for September.

THIS IS YOUR HOTEL RESERVATION COUPON

Mrs. Louise D. Perkins, Director
Housing Bureau
Cleveland Convention and Visitors' Bureau, Inc.
511 Terminal Tower
Cleveland 13, Ohio

Date of Application .....

Please reserve the following accommodations for the 117th Annual Meeting of the AAAS:

TYPE OF ACCOMMODATION DESIRED

Twin-Bedded..... Rate.....
Suite..... Rate..... Number in Party.....
Double Room..... Rate.....
Single Room..... Rate..... Sharing this room will be:
.....persons.....
(Enumerate and attach list giving name and address of each person, including yourself)

CHOICE OF HOTEL

First Choice..... Second Choice..... Third Choice.....

DATE OF ARRIVAL..... DEPARTURE DATE.....
(These *must* be indicated)

SIGNED .....
(Please print or type)

ADDRESS .....
(Street) (City and Zone) (State)

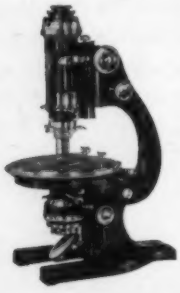
Mail this now to the Housing Bureau.

Rooms will be assigned and confirmed in order of receipt of reservation.
Hotels will confirm directly in two weeks or less.

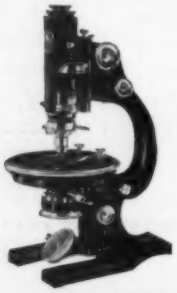
A New Series of

SPENCER POLARIZING MICROSCOPES

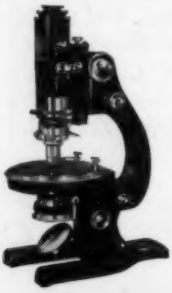
with Polaroid Polarizers and Analyzers



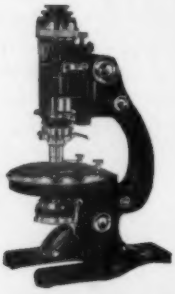
RESEARCH POLARIZING MICROSCOPE No. P37A



LARGE POLARIZING MICROSCOPE No. P39A



POLARIZING MICROSCOPE No. P41AC



POLARIZING MICROSCOPE No. P40AC

During the past five years two Spencer Polarizing Microscopes have been regularly equipped with Polaroid polarizers and analyzers. These have proven so successful that we are now offering a complete line of instruments with polaroid elements. This means substantial savings to you, whether you buy the simplest or most elaborate. Experience has shown that performance is outstanding in every respect—durability, resistance to heat, sensitivity of extinction point, image contrast, and freedom from residual color. Spencer Polarizing Microscopes with Ahrens prisms are still available. Choose your polarizing microscope from this extensive line of American-made instruments for assurance of finest performance and readily available service. Ask your AO Spencer Distributor to show you the new microscopes with Polaroid elements, or write Dept. M4.

American Optical COMPANY

INSTRUMENT DIVISION • BUFFALO 15, NEW YORK

Makers of Precision Optical Instruments for over 100 Years